THE DETERMINANTS OF RISK PERCEPTIONS OF TSUNAMIS IN OAHU, HAWAII: PUBLIC HEALTH IMPLICATIONS

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DEDICATION

I would like to dedicate this dissertation to all those people who have perished from tsunamis in Hawaii, and most especially to

Mrs. Hanami Kiyosaki

who lost her life

the night of the May 23, 1960 Hilo tsunami.

EPIGRAPH

"Saigai wa wasureta koro ni yattekuru."

—

"Natural disasters may invade again when the people have forgotten the past one."

— Japanese Proverb

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ABSTRACT

It has been over 35 years since the last destructive tsunami has impacted the Hawaiian Islands. Subsequent population growth, economic development and an ever increasing tourist industry have all inadvertently increased the potentially destructive impact which a "great" tsunami could have on life and property. Many people have had no direct experience with a tsunami of low probability and high consequence. On Oahu alone, approximately 60,000 individuals reside within a tsunami inundation zone while many others work and/or travel within these danger zones.

An exploratory cross sectional survey of a random sample of the jury pool obtained from the First Circuit Court in Honolulu drawn from the adult population of the City and County of Honolulu (n = 357) was conducted to determine the risk perception of tsunamis. A self administered questionnaire was distributed to the jury pool and the results were analyzed by standard univariate statistics and by measures of association and correlation.

Comprehension of tsunami nomenclature was particularly problematic for many of the survey respondents. The physical location of tsunami evacuation zones, the comprehension of words such as tsunami, inundation and run-up and the generating mechanism of tsunamis posed significant confusion among the sample respondents.

Tsunami-related newspaper articles from 1900 to 1995 were categorized and evaluated as to risk perception content. Those newspaper articles published immediately after a tsunami had occurred were primarily concerned with mortality and morbidity statistics with little emphasis on risk perception characteristics.

Various sociodemographic characteristics of the survey participants such as age, gender, education, length of residency, total family income, racial or ethnic characteristics and religious preference all influence the risk perception of tsunamis.

Respondents who had lower educational attainment and income levels were far more fearful of tsunamis than those of higher educational and income levels. Likewise, reducing the cost to future generations by limiting construction within inundation zones was favored by those respondents with lower educational and income levels. Religious preference did not appear to influence the risk perception of tsunamis. The race/ethnicity of the respondent influenced the risk perception of tsunamis; "Caucasians" dreaded tsunamis less than those of "Asian", "Pacific Islanders" and "Other" racial or ethnic groups. Survey respondents indicated that they could control what happens to them should they be impacted by a tsunami and that the individual and not the government should be responsible for protecting their health and safety.

The media, most notably radio and television, is the primary source of tsunami-related information with less information received from personal experience, family and friends and schools.

A cognitive map was constructed which places how much the respondent knows and worries about tsunamis in relation to 26 natural and technological hazards. Tsunamis were ranked high in respondent knowledge, but ranked relatively low in worry when compared with other more salient hazards.

The determinants and public health implications are discussed in relation to the risk perception of tsunamis. The present term-of-choice for an area at risk for flooding during a tsunami (tsunami evacuation zone) should be reconsidered and termed "tsunami danger zone". Additional proactive strategies are suggested to increase the awareness of the population to the risks which tsunamis pose to their health and safety.

KEY WORDS: Tsunamis; risk perception; risk characterization; natural hazards; public health.

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CHAPTER 1

INTRODUCTION

On April 2, 1946, just one day after a seismic event off the coast of Alaska generated a pan-Pacific tsunami which struck the Hawaiian Islands, the lead headline in the Honolulu Advertiser read: "79 KILLED, 51 INJURED AS WAVE TOLL GROWS." Unfortunately, this estimate would prove to be conservative when the final statistics of the most devastating tsunami to ever strike the Hawaiian Islands in modern history were tallied. Approximately 159 people lost their lives as a result of this tsunami with an additional 168 people injured (Cox, 1987). Included in this figure were sixteen school children and five of their teachers who died when they were washed out to sea at Lapahoehoe. Disaster struck again fourteen years later on May 23, 1960, when another devastating tsunami struck the Hawaiian Islands which resulted in 61 deaths and 43 injured.

Since 1960, the population of Hawaii has grown from 632,772 to 1,159,600 which includes military personnel, military dependents, nonresident visitors and new residents (United States Census, 1960; State of Hawaii Data Book, 1994). On Oahu alone, approximately 60,537 individuals reside in tsunami evacuation zones. Subsequent population growth, economic development and an ever increasing tourist industry have all inadvertently increased the potentially destructive impact which a "great" tsunami could have on life and property. Many of these people, including full-time residents, have had no direct experience with a tsunami of potential high consequence to life and property (see Appendix A, Tables A1 & A2; Appendix B, Figures B1, B2, B3 & B4).

Because many years have passed since a destructive tsunami has struck the Hawaiian Islands this dissertation explored the risk perception of tsunamis to the residents of Oahu. Inquiry into the comprehension of tsunami nomenclature, data gathering channels, communication channels, newspaper coverage and the relative cognitive and emotional placement of tsunamis in relation to 26 natural or technological hazards was also explored.

More specifically, this research examined and attempted to determine if and how survey participants comprehended tsunami nomenclature. In other words, did survey participants comprehend the "specialty language" which is used by the scientific community to explain complex and technical concepts related to tsunamis (Chapman & Lupton, 1994)?

What people are "likely to do" versus what people "should do" in the event of a major tsunami was explored by examining the communication channels employed by survey respondents to a theoretical versus an actual Civil Defense tsunami warning. This survey also explored various data-gathering channels which survey participants access to obtain tsunami-related information.

The media can set the agenda for what news content is presented to the public (Bryant & Zillmann, 1994). McCombs (1994) states that "not only does the news media largely determine our awareness of the world at large, supplying the major elements of our pictures of the world, they also influence the prominence of those elements in the picture" (p. 4). Therefore, an analysis of Hawaii newspaper articles covering tsunami-related events of 1946, 1960, 1975, 1986 and 1994 was performed to determine the extent to which articles were concerned with tsunami risk perception issues. (Bryant & Zillmann, 1994).

How people perceive the risk of tsunamis in relation to a threat to their lives and property, and how they respond to Civil Defense tsunami warnings, poses serious public health implications. Few studies have measured either the risk perception of the public in relation to tsunamis or the communication processes which affect the decision of the individual to evacuate or not evacuate a hazard area after a tsunami warning has been issued. Previous research indicated that people who have experienced a tsunami differ in their risk perception and evacuation response (Ayre, et al., 1975; Havinghurst, 1967). These researchers noted that many people followed Civil Defense warnings and evacuated to higher ground; however, not all people were as conscientious.

This research examined the perception of the risks posed to the health and safety of the survey participants in relation to tsunami hazards. Specific questions such as: (1) whether or not the risks from tsunamis are voluntarily undertaken; (2) can the risks from tsunamis be easily reduced; (3) how familiar are survey respondents with tsunamis; (4) how much is known by the government and science concerning the risks of tsunamis; (5) do survey respondents understand what will happen to them should they be exposed to a tsunami; (6) do survey participants feel that they can control what happens to them should they be impacted by a tsunami; (7) what is the comprehension of the survey participants as to the catastrophic potential of tsunamis; (8) how often do the respondents feel tsunamis will occur in Hawaii and the world; (9) do the participants worry about tsunamis when they are near the vicinity of the sea shore (i.e., work, residence, swimming, boating, surfing, fishing); and finally, (10) does the religiosity or spirituality of the individual influence their risk perception of tsunamis, was explored in this research.

Finally, previous research that determined which natural or technological hazards most concern people in their "everyday" lives has demonstrated that hazards which have a high probability and low consequence take priority over events of low probability and high consequence (Slovic et al., 1985). This survey examined where the survey participants cognitively and emotionally placed tsunamis in relation to 26 natural and/or technological hazards.

The information obtained from analyzing the relationship between the sociodemographic characteristics and risk perception attitudes of the residents of Oahu could possibly lead to the formulation of strategies to increase preventive risk aversion behavior via active or passive educational programs. Hopefully, the information generated by this research can help those charged with protecting the public health to extrapolate results from this research to other hazards such as hurricanes, flash floods, earthquakes and volcanic eruptions, as well as to identify areas in need of future research.

This dissertation is organized into chapters as follows: Chapter 1 briefly presents the reasons why it is important to examine the risk perceptions of tsunamis by Oahu residents; Chapter 2 reviews the literature concerning the geophysical characteristics of tsunamigenesis which is presented to help familiarize the reader with tsunami nomenclature; this section is then followed by a brief introduction to the mythology which this natural hazard has elicited world-wide, but especially in Hawaii, and a short history of major tsunamis around the world. Various economic, media, psychological, communication, and sociological influences on risk perception and human experiences with tsunamis are included; Chapter 3 includes methodology, statistics and limitations of this research; Chapter 4 details the findings of this study in relation to the research questions. The final chapter in this dissertation discusses the results of this research and summarizes the determinants of risk perception and the consequent public health implications.

CHAPTER 2

LITERATURE REVIEW

This chapter presents an overview of the geophysical mechanisms which produce tsunamis, as well as both familiar and modern tsunami-related nomenclature which will help the reader understand subsequent sections of the literature review. This section explored: the public health impact of tsunamis, the economic consequences of tsunami impact, various physical and political mitigation actions, and the tsunami warning system. Following this section a brief introduction to tsunami mythology will illustrate how humans "made sense" of the mechanisms and origins of this natural hazard. The human experience with tsunamis then follows this section and discusses the various devastating tsunamis which have impacted the world but most importantly the Islands of Hawaii. Various sociological and psychological theories of risk perception will be reviewed as they relate to natural or technological hazards. The literature concerning the influence of the media to either proactively and/or reactively set the agenda for news coverage of natural or technological hazards, as well as an examination of the communication channels which people employ in their data-gathering activities will be reviewed in relation to preparation for impending tsunamis. A review of the literature concerning the sociodemographic influences on risk perception beliefs and attitudes concerning natural and technological risks will be presented. The literature which covers how people prioritize the risks of various natural and/or technological hazards in relation to tsunamis will be explored in this literature review.

Physical Characteristics of Tsunamis

The geophysical mechanisms of tsunamigenesis will be presented in this section to acquaint the reader with relevant tsunami nomenclature and to better prepare the reader to comprehend the often confusing physical and linguistic components of tsunamiology.

Nomenclature and mechanics. The Japanese word "tsunami" means "great wave in harbor" (Dudley & Lee, 1988). The nomenclature for tsunamis had consisted of either "seismic sea waves" or as "tidal waves"; however, the word tsunami (pronounced tsoo-nah-mee) is now recognized as the etymological word-of-choice in scientific usage, and with increasing frequency in the popular culture (Ayre, et al., 1975; Lander, et al., 1993). However, Lander et al. (1993) notes that "Tsunamis are most often incorrectly referred to as 'tidal waves' by the general public" (p.1). Tsunamis can be defined as "a train of progressive long waves generated in the ocean or a small connected body of water by an impulsive disturbance" (Cox, 1963) (see Appendix B, Figure B5). Adams and Nakashizuka (1985) have proposed a tsunami nomenclature which describes a tsunami according to its amplitude (see Appendix C). A micro-tsunami is of such small amplitude that it can only be observed and measured by instruments. The normalized wave heights for this kind of tsunami range from less than 20 centimeters but more than two centimeters from peak to trough. A mini-tsunami produces a normalized wave which is less than 200 centimeters (two meters) but more than 20 centimeters from peak to trough. Tsunamis (a normalized wave which is greater than 200 cm) are mainly generated by three mechanisms: submarine faulting, volcanic activity and by aerial or submarine landslides. To a lesser extent, but nevertheless a potential source of tsunamis, are those energy generating forces which can be produced by both anthropogenic (i.e., bombs) and extraterrestrial (i.e., meteorites) means.

Tsunamis are usually generated by shallow submarine faulting, which occurs near the edge of a coastline. However, only 3 to 5% of all seismic events produce tsunamis. (W. Mass, Director - Pacific Tsunami Warning Center, personal communication, October 10, 1995). A seismic event, or impulsive disturbance, is the generating mechanism which produces an earthquake. Seismic events measuring 7.0 or less on the Richter Scale produce very little movement of the seafloor with virtually to no water movement (Ayre, 1975; Dudley & Lee, 1988). Seismic events measuring greater than 7.2 or more on the Richter Scale and which generate both an earthquake and accompanying tsunami are termed tsunamiative or tsunamigenic (Adams & Nakashizuka, 1985; Dudley & Lee, 1988).

Another source of tsunamis can result from aerial landslides, submarine landslides or a combination of both. This tsunami generating mechanism is second only to submarine faulting in causing tsunamis. Dudley and Lee (1988) describe how a cliff overhanging Kealakekua Bay on the island of Hawaii fell into the ocean on August 21, 1951 inundating the shore of Napoopoo by a two foot wave. The largest tsunami ever recorded occurred on July 9, 1958 in Lituya Bay, Alaska. An aerial landslide had plunged into the confined bay producing a tsunami run-up which measured approximately 1,740 feet above the shoreline (Dudley & Lee, 1988). (Note: This kind of "tsunami" is referred to by geologists and oceanographers as a swash.)

Volcanic activity can also cause tsunamis when a flank of a volcano is either uplifted or depressed producing an event similar to that caused by submarine faulting activity (Dudley & Lee, 1988). Tsunamis can also result from the sudden explosion of submarine or shoreline volcanoes. The Indonesian volcano, Krakatoa, exploded in 1883 and produced a tsunami with waves measuring approximately 130 feet in amplitude.

Both landslides and volcanic sources of tsunamis can be damaging locally, but they do not contain the same amount of energy (tsunamion) as a tsunami caused by submarine faulting as a result of a seismic event. Two important characteristics of tsunamis are that they can be of rapid onset (local tsunami) or of long duration (tele-tsunami) (Gonzales & Bernard, 1992). Beinin (1985) and Hass and Trainer (1973) have developed tsunami classifications based on wave height or according to type of onset, physical cues, evacuation time and preventive procedures following an earthquake (see Appendix A, Tables A3 & A4). Communities located near the source of a locally generated tsunami have little or no time to prepare for its arrival and therefore hazard mitigation should stress rapid evacuation. A good first warning for coastal communities of an impending tsunami is the earthquake itself.

For those tsunamis which are of long duration, the initial tsunami may arrive within an hour, with more destructive waves occurring sometimes 3 to 8 hours later. For example, a seismic event occurred off the coast of Eureka, California on April 25, 1992 which impacted Crescent City, California within 20 minutes of generation. However, the maximum waves heights occurred within 3 to 4 hours after the generating event (Bernard et al. (1993). Therefore, hazard mitigation for this type of tsunami should emphasize the judicial return of residents to low-lying areas, the potential for long term evacuation following severe destruction of the coastal communities and the need for adequate provisions to ensure the resident's needs and safety.

Once a tsunami has been generated by a seismic event, the speed at which the waves travel varies with water depth. At the present time it is not possible to predict wave heights. However, once the epicenter of the seismic event has been determined, the travel time for tsunami impact can be calculated. A tsunami usually travels in all directions, but depending on its geographic and topographic source, may focus primarily in one direction. This phenomenon explains why some islands close to the source of tsunami generation are not as affected as ones a considerable distance from the tsunamigenic seismic event. Also tsunamis are usually not large in isolated islands such as Midway or Wake Islands, but can be in the Hawaiian Islands. This phenomenon occurs because large islands in close proximity to one another exhibit relatively extensive submarine topographies which slows the movement of the tsunami as it progresses across the ocean (Dudley & Lee, 1988). A shadowing effect also occurs when a tsunami passes around an island causing some of its tremendous power to be dissipated. This mechanical attenuation produces "breaks" in the physical integrity of the tsunami. The speed at which tsunamis travel is calculated by $v = gd^{1/2}$ (v= velocity, g= acceleration by gravity and d= depth of the water) (Ayre, 1975). Tsunamis, which usually consist of a series of waves (train of waves), can travel on the open ocean at 350-500 or even 600 mph and cross the vast expanse of the Pacific (12,000 - 14,000 miles) in approximately 20-25 hours. The time period between crests of the wave train can vary from approximately 5-60 minutes or longer, and the distance between crests can be 50-100 miles or more. Tsunami waves are approximately one foot or less on the open ocean and are neither readily discernible to vessels at sea or by aircraft (Ayre, 1975).

The tsunami mid-ocean height, as well as period and direction of approach, will determine the potential impact of a tsunami. When a series of tsunami waves enter shallow water, its momentum begins to slow to 40 mph or less (Ayre, 1975). This action causes the water to back up and produce wave heights which vary according to the submarine topography. Coastline configurations, submarine contours, and wave characteristics all affect how a tsunami will affect a coastline. The submarine topography will determine if the tsunami will be a "spiller" or "plunger". A spiller results when the submarine topography slopes gently causing the water to rise slowly and flood a coastal area (Myles, 1985). Plungers result when a tsunami encounters a steep angle or slope producing a characteristic leading wave of varying amplitude (Myles, 1985). Some tsunamis may reach a height of 50 feet or more at one section of coast only to be rather minimal at an adjacent coastline (Ayre, 1975). A natural warning for an impending tsunami occurs when the water in a bay or coast begins to recede revealing the submarine topography. This phenomenon usually occurs when a tsunami, which is about to strike shore, is preceded by a trough. If the tsunami is not preceded by a trough, its height above the tide level at the time of the tsunami will usually hit the coastline with considerable force, thereby causing extensive damage. Both spillers and plungers can occur along the same stretch of affected coastline as witnessed during the Aleutians—Hawaiian tsunami of 1946 (Myles, 1985). Once a tsunami has been generated it can repeatedly "bounce back" to the originating source and often takes weeks for these reverberations to subside (Myles, 1985) (See Appendix B, Figure B5).

The majority of locally generated (urgent) tsunamis (4 in 150 years and only one causing serious damage) have occurred as the result of a seismic event which had taken place off the Island of Hawaii followed next by aerial and submarine landslides (Cox & Morgan, 1972; Pararas-Carayannis, 1969) (See Appendix B, Figures B6 & B7). These urgent tsunamis are relatively rare in occurrence; however, the short lead-time in which effective evacuation of low-lying coastal areas can take place can result in serious consequences to the health and safety of the population-at-risk. For example on April 2, 1868 a locally generated earthquake and resultant tsunami struck the coast off the Puna and Kau Districts of the island of Hawaii which resulted in 47 deaths (Cox & Morgan, 1972). Most of the deaths, however, were attributed to a landslide which occurred in Wood Valley on the slope of Mauna Loa. Almost 100 years later, a seismic event off the coast of Kalapana, Hawaii on November 29, 1975 caused a locally-generated 20-foot tsunami after a portion of the Kalapana coast subsided into the ocean at Halape. Most people evacuated because they were aware that an earthquake could generate a tsunami, as well as the occurrence of an initial inundating wave which gave every indication that a tsunami had been generated. Unfortunately, the tsunami resulted in two deaths and $1.5 million in damage (Loomis, 1975). Although it is notable that very few people lost their lives from this locally generated tsunami, it must be recognized that the area of the coast which was impacted by this event was relatively sparsely inhabited. One possibility for the low morbidity and mortality statistics resulting from this event could be that the residents of the Kau and Puna Districts of the Island of Hawaii may perceive locally generated tsunamis as a threat to their health and safety and evacuate in a timely manner. Interestingly, in the intervening 20 years since the last locally generated tsunami has impacted the island of Hawaii, the population inhabiting low-lying coastal areas has increased (see Appendix B, Figure B8). It would be interesting to conjecture if the new populace would be as "lucky" when and if the next locally generated tsunami were to impact a more densely inhabited portion of the island.

Of all the tsunami generating sources, geophysical, anthropogenic and extraterrestrial, noted in this review, seismic events which produce pan-Pacific tsunamis will often have the most destructive effect on human civilizations far removed from the generating source.

Public Health and Economic Impact from Tsunamis

The public health consequences and concomitant economic impact of tsunamis will be explored in this section. Emphasis will be placed on the human and structural consequences of this low probability, but high consequence, natural hazard.

Public health concerns. The public's health could be impacted by a destructive tsunami by putting lives at-risk, as well as compromising environmental health and sanitation quality. For example, damage to municipal infrastructure (bridges, roads, beaches, docks, fuel storage tanks, electric and telephone utilities, airplane hangers and runways, railroad track) which must be or are within inundation zones will be affected from a tsunami (Pan American Health Organization, 1982; National Oceanic and Atmospheric Administration, (NOAA), 1993). Should these transportation, energy and communication networks be damaged it would isolate not only the communities impacted by the tsunami but also distal communities which are dependent on an intact municipal infrastructure. A destructive tsunami would also produce considerable environmental health consequences resulting from soil erosion and sedimentation, damaged sewage and water facilities, and increases in vector breeding sites. Should the water supply system be contaminated with sewage following a tsunami then an increase in communicable diseases can be expected if proper sterilization techniques are not instituted (Pan

American Health Organization, 1982). Sanitation concerns must be of top priority after a tsunami has struck to safeguard the public's health (i.e., maintaining a potable water supply, safe food sources, as well as the removal potentially toxic debris from the environment) (Pan American Health Organization, 1982).

The human effects of a tsunami can range from overt mortality and morbidity consequences to more subtle societal ramifications. Cox (1987) noted an equal incidence of injuries and death as a result of tsunami impact. The major causes of death from tsunamis, other than overt physical trauma and drowning, is through pneumonia and hypothermia as a result of submersion in sea water (Beinin, 1985). Maintenance of the public's mental health is of utmost importance following a destructive natural disaster. Quarantelli (1965) noted that recovery from a disaster will often reveal predisaster social issues. A breakdown of societal behavior would impact the public's health through increased domestic violence and other antisocial behaviors, such as civic and domestic violence and looting (Quarantelli, 1965). Preventive public health strategies, as well as postdisaster mental health intervention would lessen the impact a natural disaster would have on the social structure of society.

Economic impact. Tsunamis have caused approximately 400 casualties and over $160 million worth of damage to the United States from 1900-1971 (Ayre, 1975). A tsunami occurred off the Nicaraguan coast on September 1, 1992 which caused 116 deaths (63 unaccounted) and directly or indirectly affected 40,000+ people and cost the Nicaraguan government approximately $25 million in damage (Jovel, 1992). The National Oceanic and Atmospheric Administration predicts that if a similar tsunami were to strike the coast of California, losses would be in the hundreds of millions of dollars and thousands of lives lost (National Oceanic and Atmospheric Administration, 1993). The unpredictable nature of tsunamis, coupled with an ever increasing coastal population, has prompted risk analysts to devise models which can calculate the effects of zoning of coastal property which is subject to tsunami damage.

Morgan (1984) has developed the Tsunami Avoidable Susceptibility Index (TASI) which calculates the probability of tsunami inundation of X height and Y inland penetration with human use of the coastline. The value represents the degree of hazard which an activity poses to the safety of the populace. The human use of the coastline is evaluated according to the need for location of an activity within an inundation zone and how many people would be affected by tsunami inundation. The formula TASI = P (H) (P = physical component factor and H = human use factor) is used to determine the degree of hazard of a particular activity. A TASI value which is equal to zero represents no hazard, while a high value represents severe hazard to life and property located near the coast. The TASI value is a useful measure for the zoning of coastal property and provides planners with a logical framework for regional planning (Morgan, 1984).

Water-supported activities utilized for commerce, as well as pleasure, will be greatly affected by a damaging tsunami, especially if the municipal infrastructure is greatly disrupted (Ayre, 1975). As a result of this damage, small isolated communities as well as developing countries with minimal financial resources may experience great financial burden resulting in long lasting economic consequences (Ayre, 1975).

Wright and Rossi, (1981) state that there is a strong charitable tendency of Americans to come to the aid of disaster victims in time of need. When the Federal Government declares a “State of Emergency” for an area severely impacted by a natural or technological disaster, a “socialization” of the risk occurs (i.e., shared responsibility and shared expense). Various federal agencies have developed programs to minimize the individual’s economic risk posed by a disaster (e.g., Disaster Relief and Emergency Assistance Act, 1988). However, with the cost of natural disasters rising, the Federal

Government has been proposing preventive "cost-sharing" and structural and nonstructural mitigative activities to lessen the public's financial burden.

Kunreuther (1973) observed that individuals and communities will adopt different risk levels depending on who is to shoulder the cost of a disaster. In an ideal world, State and local community leaders should take a more proactive attitude concerning the fiscal impact which a natural hazard will have on postdisaster reconstruction of the municipal infrastructure which is destroyed or damaged; however, as previously noted, economic and political action is usually "event driven" with other more salient community problems taking precedence in a community's fiscal appropriations (Wright & Rossi, 1981). Wright and Rossi (1981) suggest that following a destructive disaster opinion leaders and legislators would be less likely to allow affected constituents to rebuild in areas prone to disaster if the Federal Government should decide to amend its generous disaster assistance programs and require individuals, as well as state and local governments to assume greater responsibility for shouldering the fiscal burden of postdisaster reconstruction. For instance, oceanfront properties in Hawaii are popular areas in which people prefer to reside. If a tsunami were to destroy many of these expensive properties, will the public hold the state responsible to insure that no public funds are spent to restore state funded infrastructure within known tsunami inundation zones? How politically-blind can state and local officials be when faced with such a situation? Would people be as sympathetic to landowners who lose properties worth millions of dollars if it meant that everyone would have to partially shoulder the reconstruction costs? The insurance industry, post Hurricane Iniki (1992), has either stopped insuring residents of the State of Hawaii or raised their insurance premiums for hurricane and wind damage because of the extraordinary costs which this natural disaster wrought on their solvency. If a similar, albeit geographically limited, situation should occur following a destructive tsunami would the public demand structural and nonstructural mitigation?

Thus, following a destructive tsunami, the public's health can be impacted by: overt physical impact; loss of municipal infrastructure; fiscal allocation and appropriation of State and Federal resources; and political agenda setting.

Structural and Nonstructural Tsunami Mitigation

Mitigation of the impact which natural disasters may have on a community can be accomplished either by structural or nonstructural methods or by a combination of both (Alexander, 1991: Wright & Rossi, 1981). Bays which are "U" and "V" shaped can be especially hard hit by tsunamis (Dudley & Lee, 1988). For example, Hilo Bay, a U-shaped bay, is often subjected to tsunami impact. Breakwaters and other structural mitigative barriers have been proposed to help lessen the effects of future tsunamis on Hilo Bay. Following the 1960 tsunami, which had virtually destroyed the downtown area of Hilo, nonstructural zoning, which prohibits construction of buildings in inundation zones, was enacted. However, due to economic pressures, hotels were constructed within inundation zones on Banyan Drive in Hilo (Morgan, 1984).

Tsunami structural mitigation. Tsunami structural mitigation consists of engineering methods and architectural barriers which are designed to contain excess water and prevent flooding (e.g., dams, levees, channels, seawalls and other structures) (Alexander, 1991; Kunreuther, 1973; Wright and Rossi, 1981). This type of mitigation is passive since it does not require behavioral changes from individuals or community. Nonstructural mitigation consists of efficient landuse management, operations research, risk analysis, education, economics and building codes in high risk areas (Alexander, 1991; Ayre et al., 1975; Cox, 1979; Wright and Rossi, 1981). The National Flood Insurance Program (NFIP), Coastal Zone Management Program, and the Earthquake Hazards Reduction Act (1977) were developed to emphasize land use management

(Wright & Rossi, 1981). The proper planning and evacuation zoning of inundation areas, as well as the enforcement of tsunami resistant building and construction standards, should lessen the impact this natural hazard will have on the individual and community. Ayre et al. (1975) further suggests that nonstructural mitigative actions such as locating storage tanks for combustible or contamination materials outside tsunami hazard zones. Airport and land transportation, as well as facilities where people congregate in large numbers (i.e., schools, hospitals, public buildings, emergency control centers) should be located outside of tsunamis inundation zones.

Structural mitigation attained by tsunami engineering can actually increase the public's risk from injury during a natural disaster (Wright & Rossi, 1981). The "garden-variety" tsunami has been the standard model for most structural regulations concerning building and infrastructure construction near an inundation zone, but what about those tsunamis which exceeds the standard? Most structural barriers will fail when stressed by a force for which they were not designed to withstand (Wright & Rossi, 1981). A false sense of security may produce unrealistic risk perceptions of the efficacy of mechanical barriers to effectively protect the populace from the deleterious effects of a destructive tsunami when building code regulations are designed for the "normal" tsunami. For example, many of the high-rise buildings within inundation zones have been designed with "open" lobbies to allow water to flow through the building unimpeded. These buildings have not been tested to determine if they will withstand an actual tsunami beyond which was determined by computer model(s). Ayer et al. (1975) further notes that suitable structural mitigation can consist of: the construction of breakwaters and sea walls; planting of forests along the coastline which will help protect low-lying areas; better engineered docks and shore facilities which will withstand tsunami wave forces; flood proofing techniques; and the provision of emergency cut-offs in oil pipelines, and other utilities to help prevent leakage of flammable materials.

Tsunami nonstructural mitigation. Wright and Rossi (1981) suggest that the political process for mitigation (structural or nonstructural) is unfortunately "event driven". It often takes a catastrophe to enact legislative and mitigative activities to prevent future catastrophes from occurring. However, for those hazards which are of low probability, a "politics of periphery" or "politics of low salience" will often determine what mitigative activities will occur (Mittler, 1989; Wright & Rossi, 1981). Neuman (1990) suggests that "we need to understand what in the nature of an event or issue pushes it over the threshold and what defines it as a public rather than a private concern" (p. 174). Interestingly, Federal Executive Order 12699 (Tsunami Hazard Reduction Program) requires a reduction of tsunami threat to federal operations. This order mandates "federal agencies to ensure that federally constructed or assisted buildings satisfy cost-effective seismic building standards - Potential impact on U.S. Navy facilities - Pearl Harbor and San Diego (as well as U.S. Postal Service, Army Corps of Engineers and other Federal Agencies etc.)" (National Oceanic and Atmospheric Administration, 1993, p. 9).

State and local officials are minimally concerned with low probability events when allocating resources for public use (Sutphen & Bott, 1990; Wright & Rossi, 1981). For example, a recent poll taken of California residents concerning both environmental and societal problems, showed that residents are far more concerned with "bread and butter" problems, such as the social impact of pornography on their culture, rather than a potentially catastrophic earthquake (Wright & Rossi, 1981).

Assuredly, disasters will occur sooner or later. Wright and Rossi (1981) suggest that real policies are enacted only when the disaster has become a reality and not when it is still hypothetical. Pratt (1984) noted the "policy of non-action" which is taken by health officials to make no policy recommendations for regulation or response if it is not supported by scientific inquiry. Similarly, land use patterns will usually change following a natural disaster and not when the risk is purely hypothetical. The "politics of low salience" will change to a "politics of high salience" usually after a damaging event has occurred (Wright & Rossi, 1981). Quite often the political future of elected officials will be determined by how well these individuals managed a hazard both retrospectively and prospectively. Unfortunately, it takes a disaster to occur before mitigative activities are instigated.

Tsunami Detection and Warning

Over 159 people were killed following the April 1, 1946 tsunami which impacted the Hawaiian Islands. Unfortunately, the people of the Territory of Hawaii were unaware that they would be impacted by the largest single disaster to hit the Islands of Hawaii in modern history. The resultant loss of life and property coupled with public concern revealed the need for a better tsunami warning system. This section will explore the various mechanisms in which tsunamis can be predicted and the warning systems employed to warn the public of an ensuing tsunami.

Pacific tsunami detection and warning system. The April 1, 1946 destructive tsunami which primarily impacted Hilo, Hawaii, clearly demonstrated the need for the establishment of a tsunami early warning system for the Pacific Basin. In 1948 the Geodesic Survey established the Pacific Tsunami Warning Center (PTWC) in Ewa Beach, Hawaii. This center is equipped to receive information from 33 seismograph stations and 53 tide stations. The PTWC can then determine if a potential tsunamigenic earthquake has been generated by determining the magnitude and location, pinpointing its epicenter by triangulation and analyzing data from tide gauges (Myles, 1985).

Tsunami warnings consist of two phases: tsunami watch bulletin and tsunami warning bulletin. A tsunami watch bulletin is issued when a seismic event has been detected which is of sufficient magnitude and in such a location that the generation of a tsunami is possible. If tide gauges located closest to the epicenter of a submarine earthquake detect physical signs that a tsunami has been generated, then a tsunami warning bulletin will be declared by the Pacific Tsunami Warning Center (PTWC) upon receipt of positive evidence that a tsunami exists. The tsunami warning will contain estimated times of arrival at tide stations in the warning system. Tsunami warnings are only an advisory to local law enforcement agencies, military and civil defense authorities and only they can issue an evacuation order for individuals located in inundation zones (Myles, 1985). A tsunami watch cancellation bulletin will be issued when the PTWC determines that a tsunami has not been generated.

This system, however, was ineffective in preparing for locally generated tsunamis, therefore a regional system was developed in 1975. This system is based at the Honolulu Observatory and consists of a quadripartite seismographic network with tide stations located on the island of Hawaii and Maui, undersea pressure-sensitive gauges and four telemetering tide stations (Myles, 1985). The Honolulu Observatory in communication with Hawaii Civil Defense issues both watches and warnings of locally generated tsunamis.

Because time is of the essence in preparation for potentially destructive tsunamis, an automated system which utilizes a Geostationary Operational Environmental Satellite (GOES) in an earth-synchronous orbit located 22,300 miles above equator, was developed in 1984 (Myles, 1985). The GOES satellite is a specific type of Geosynchronous Orbiting Satellite (GEOS). The satellite quickly receives tide gauge data from remote areas like Easter Island or the Galapagos Islands and instantly relays the information to Wallops Station, Virginia. Thus, real-time information can be transmitted to the PTWC and regional tsunami centers which clearly advances tsunami forecasting and preparation. NOAA has also proposed a potential tsunami early warning system incorporating a network of six deep-ocean tsunami gauges which will report data in real time to the two zones affecting Hawaii and the Pacific Northwest (Cascadia Subduction

Zone and the Alaska and Aleutian Subduction Zone) (National Oceanic and Atmospheric Administration, 1993). These measurements should decrease the quantity of false alerts and hopefully increase the public's response to tsunami warnings, if enacted (funded) (National Oceanic and Atmospheric Administration, 1993).

The Tsunami Warning System can accurately estimate the time of arrival of tsunamis, but as yet the magnitude and force of a tsunami can not be determined (Myles, 1985). Variations in submarine topography, point of wave origin and submarine earthquake magnitude all influence the potential destructiveness of a tsunami. The tsunami warning centers, operated by the USA, Japan and Russia, can confirm that a potentially tsunamigenic earthquake has occurred, calculate the estimated time of arrival (ETA) for a tele-tsunami, and as time progresses, can confirm whether or not a tsunami has been generated. However, the tsunami warning system cannot predict the size of the tsunami nor the potential impact of a tsunami when it reaches landfall (National Oceanic and Atmospheric Administration, 1993). NOAA is the only federal agency responsible for tsunami notification in the United States of America.

Future technological advances will perhaps allow computer generated models to accurately predict the amplitude, force and the potential destruction of tsunamis when they reach landfall, thus eliminating the uncertainty of tsunami forecasting which exists today (National Oceanic and Atmospheric Administration, 1993). A major portion of tsunami research in the future will be in acquiring precision in prediction and improving the tsunami warning process.

Tsunami Mythology and History

The people inhabiting low-lying coastal communities throughout the world have been impacted by tsunamis for millennia. Mythologies were developed to help explain the vagaries of Nature and of "God" to visit such destruction on Mankind. The people of Oceania, and those residing along the Pacific Rim, have been most impacted by this force of Nature. A brief history of tsunami mythology and history will be presented in this section to help define how a low probability but high consequence hazard can affect human life and culture.

Tsunami mythology. Many destructive tsunamis have occurred throughout history which have caused considerable damage to life and property (Cox, 1987; Dudley & Lee, 1988; Myles, 1985; Pararas-Carayannis, 1969). Tsunamis were generally believed to be an "act of God" and the resultant damage to life and property was considered to be uncontrollable by humans (Pararas-Carayannis, 1983; Wijkman & Timberlake, 1984). For instance, many researchers have suggested that the cataclysmic volcanic explosion and resultant tsunami which occurred on the island of Santorin(i) (circa 1450 BC) resulted in the destruction of the Minoan culture and was possibly the force which destroyed the fabled land of Atlantis (Dudley & Lee, 1988; Myles, 1985). It has been hypothesized that this same event may have coincided with the Israelite exodus from Egypt and the parting of the Sea of Reeds. In either case, a devastating volcanic eruption impacted the eastern Mediterranean at this time which was chronicled by many ancient civilizations and incorporated into their mythology or legends (Myles, 1985).

The vast majority of tsunamis occur in the Pacific Basin along the seismically active tsunami-prone Pacific Rim (Dudley & Lee, 1988; Morgan, 1978) (see Appendix B, Figure B6). The people who inhabit the islands and coasts of the Pacific Basin have had extensive experience with the destructive power of tsunamis. Folklore and mythologies exist among these inhabitants to help explain the random destruction caused by "mother nature" to their communities. (Kluckhohn, 1960; Malo, 1952). For example, many legends are found in Hawaiian folklore in which the sea engulfs the land. One poignant legend tells of a woman who lives in the sea outside Waiakea, Hilo as having been lured and seduced by King Konikonia. The king is warned by the woman that her brothers (in the form of Paoo fish) will search for her; however, in order for them to search for her the sea would have to cover the land. After ten days the sea rose and overwhelmed the land until it reached the house the king. Many of the Konikonia's people were drowned; however, those who survived were able to return to the land after the water had receded (Malo, 1952).

Tsunami history. Though tsunamis are of low probability of occurrence they nevertheless appear frequently in world-wide maritime records. A brief overview of the most catastrophic tsunamis will be discussed in this section.

The islands which comprise the nation of Japan have experienced 65 destructive tsunamis between 684 and 1960 AD. The Sanriku coast of Hokkaido, Japan which is situated between Tokachi (northern boundary) and Miyagi (southern boundary) and the Tohoku District of northern Honshu have been subject to repeated tsunami destruction for hundreds of years. The Sanriku coast with its many "U" and "V" shaped bays and flatlands is particularly prone to destructive tsunamis. A tsunami occurred on July 18, 869 AD which resulted in 1,800 deaths and the destruction of hundreds of villages. Another destructive tsunami struck the Sanriku coast on August 1, 1361 which resulted in 60 deaths and destroyed 1,700 homes in the area (Murakami et al., 1993). A destructive tsunami devastated a section of the Kii peninsular on September 20, 1498 caused over 500 deaths and approximately 1,000 houses were washed out to sea. The great Meiji Sanriku tsunami (June 15, 1896) resulted in 27,122 deaths, thousands of injuries and the destruction of thousands of homes (Pararas-Carayannis, 1981). On March 3, 1933 the Sanriku coast was again devastated by a tsunami which measured approximately 90 feet in run-up and killed over 3,000 people.

A seismic event off the port city of Lisbon, Portugal in 1755 generated a tsunami which not only killed approximately 60,000 people, but consequently destroyed one of the most important centers of trade in 18th century Europe (Myles, 1985). The volcanic explosion which occurred on the island of Krakatoa, Indonesia in 1883 produced a tsunami of immense proportions which killed approximately 37,000 people and affected areas of the globe quite distant from the tsunamigenic source (Myles, 1985). Interestingly, a man-made tsunami occurred in 1917 when a munitions ship was rammed in Halifax harbor, Nova Scotia. The resultant tsunami killed approximately 1,800 people and destroyed the northern part of the City of Halifax.

The Hawaiian Islands have also been impacted by devastating tsunamis (see Appendix A, Table A4; Appendix B, Figure B7). Between 1837 and 1946 approximately 68 people have perished in the Hawaiian Islands because of destructive local and distal tsunamis (Pararas-Carayannis, 1969).

On April 1, 1946 a seismic event centered off the Aleutian Islands in Alaska generated a destructive tsunami which impacted the Hawaiian Islands and the West Coast of the United States. The tsunami resulted in approximately 159 deaths state-wide and resulted in $26,000,000 in property damages (Dudley & Lee, 1988). This tsunami was particularly destructive in the Territory of Hawaii because no warning had been given to the populace of an approaching tsunami. The U.S. Coast and Geodetic Survey knew five hours before impact on the Hawaiian Islands that the seismic event was possibly tsunamigenic but, unfortunately, failed to warn Civil Defense authorities in Hawaii of this fact!

Two smaller tsunamis impacted the Hawaiian Islands in 1952 and 1957. On November 4, 1952 a seismic event centered off the southeastern coast of the Kamchatka Peninsular, Russia, generated a tsunami which resulted in no human fatalities (six cows were lost) but did cause damage to property of over $800,000. The tsunami warning system functioned reasonably well except that sources not connected with the tsunami warning system reported erroneous information concerning which waves were the most destructive and when people could return to coastal areas (Dudley & Lee, 1988). The seismic event which occurred off the coast of Alaska on March 9, 1957 generated a tsunami which was much smaller than the tsunami of 1946 even though the magnitude of the submarine earthquake was greater than in 1946. Ironically, the island of Kauai was severely damaged by this tsunami while the island of Hawaii received little property damage (Dudley & Lee, 1988).

On May 22, 1960 a severe earthquake occurred off the coast of southern Chile which generated a Pacific-wide tsunami which resulted in a combined total of 1,000 deaths in Chile, Hawaii, Philippines, Okinawa and Japan. In Hawaii this tsunami resulted in approximately 61 fatalities and property damage of approximately $23,000,000 (Dudley & Lee, 1988).

On November 29, 1975 a locally generated tsunami occurred off the southeast coast of the island of Hawaii. This tsunami resulted in 2 fatalities and property damage valued at approximately $1,500,000 (Dudley & Lee, 1988).

On May 23, 1986 a seismic event located near the Aleutian Islands generated a mini-tsunami which affected the Hawaiian Islands. The Hawaii Civil Defense authorities issued a tsunami warning for the Hawaiian Islands when a tsunami had been verified by tide stations near the epicenter of the seismic event. The location and magnitude of the event was similar to the destructive tsunami which affected the Hawaiian Islands in 1957 which resulted in $5 million in damage. State and county offices and private businesses dismissed their personnel from work early resulting in massive traffic jams. Dismissing people from work early was perhaps not the most prudent action to have been taken. Consequent to the 1986 incident, the Department of Education and the Office of Business Services or Facilities & Support Branch, updated The Emergency Preparedness Handbook (Tsunami Response Actions) in 1988 (see Appendix E). The Tsunami Response Actions clearly outlines that "a staggered work release schedule for employees who reside in tsunami and related flood prone inundation zones" will be enacted should a tsunami threaten the Hawaiian Islands (p. 122). It is easy to imagine how many people would have been killed if the tsunami had hit a traffic jam in an inundation zone. Many thousands of beachgoers, tourists and people who worked along the coast did evacuate inland; however, many residents statewide who were warned to evacuate the beaches in Honolulu disregarded the tsunami warnings and continued to swim or surf (Dudley & Lee, 1988). Dudley and Lee (1988) observed that there was an actual influx of motor vehicles headed towards Waikiki to watch the tsunami as it came ashore. In Hilo, Hawaii many residents refused to believe that the tsunami would endanger their lives resulting in a "tsunami party time" atmosphere. Radio disc jockeys added to the confusion by broadcasting unofficial and inaccurate wave activity (Dudley & Lee, 1988). Fortunately, the tsunami resulted in run-ups ranging from 40-122 centimeters statewide (Dudley & Lee, 1988). The population was not affected by this tsunami; however, the confusion on the part of the public as to how to prepare for a potentially damaging tsunami highlighted the need for better risk communication to prevent unnecessary loss of life.

In the early morning hours of October 4, 1994 a seismic event off the coast of Hokkaido, Japan produced a mini-tsunami which was to affect the Hawaiian Islands. Like the 1986 mini-tsunami, no fatalities or property damage was reported as a result of this tsunami. However, unlike the communication problems noted during the 1986 "non-event" tsunami, the tsunami warning system functioned "perfectly". The difference between these two mini-tsunami and consequent public reaction was in the time of day the tsunami occurred. The tsunami of October 4, 1994 occurred during the early morning hours which presented Civil Defense with the enviable position of sounding the tsunami warning siren before most people had left for their daily activities. The public response to this tsunami was overwhelmingly positive as to how Civil Defense, state and local governments handled this crisis.

However, it must be remembered that this tsunami was the second "nonevent" tsunami to strike the Hawaiian Islands in less than 10 years. Pararas-Carayannis (1983) noted that "... the historical record does not reflect the potential damage that can be caused by tsunamis, since a great deal of development has taken place in the last twenty years in the coastal areas of many developing or developed coastal nations" (p. 5). The author further notes that "... the social and economic impact of future tsunamis will be extremely more severe than that of past events. It is therefore, important to plan and prepare for future events" (Pararas-Carayannis, 1983, p. 5).

Tsunamis have impacted human lives for millennia and will continue to do so unless people are informed about the consequences this natural hazard can have for life and property. The infrequency of destructive tsunamis, coupled with an ever increasing population of low-lying coastal communities, will place many people at risk who may be totally unaware of the threat to their health and safety.

Media Coverage

This section will address; the influence which editors and journalists have on setting the agenda of news content and concomitant release to the public; the influence of the media to either effectively or ineffectively transmit crucial information which may impact the public's health; and the processes which people employ to obtain germane information in their problem solving quest.

Agenda setting. Cohen (1963) stated that "the press may not be successful much of the time in telling people what to think, but [may be] stunningly successful in telling its readers what to think about" (p. 172). Indeed the media can proactively or reactively "transfer the salience of items on their news agendas to the public agenda" (McCombs, 1994, p.4). McCombs (1994) reports that those responsible for establishing what will or will not be covered in the media and that on any day "over 75% of the potential news of the day is rejected out of hand and never transmitted to the audience" (p. 4). Graber (1989) noted that journalists quite often construct reality for an audience by deliberately determining what is "covered" by newscasts. Media editors and journalists often perform a "gatekeeping" role in how and when information is relayed to the public through such avenues as space allocation, issue salience, and placement within newspapers. Hubbard et al. (1975) reported that the media often sets action and cognitive agendas which may influence the public's risk-taking behavior. Often these topics are chosen for financial consideration as to marketability, sensationalism or the particular interests of individual editors (Singer & Endreny, 1987; Wilkins & Patterson, 1987). However, it must be remembered that the news agenda, while being traditionally set by journalists, is ultimately influenced by external sources and events and responds to real world cues (McCombs, 1994).

Various researchers have reported that less informed people often rely on the mass media for information (orientation) concerning science, technology and health and for salience cues (Cronholm & Sandell, 1981; McCombs, 1994; Nelkin, 1985; Swinehart & McLeod, 1960; Tannenbaum, 1963). Individuals often seek information (orientation) which may diminish their anxiety in uncertain or complex issues especially if the information is not readily available through "unobtrusive" personal experience (McCombs, 1994).

People cope with the "flood of information" that threatens to overwhelm them by different information-processing strategies (Graber, 1988; Kosicki & McLeod, 1990; Kosicki, McLeod, & Amor, 1987; McComb, 1994). Information-processing strategies can be accomplished by selective scanning, skimming and tuning out items; active processing, going beyond or "reading through" a story to reinterpret it according to the person's needs; and reflective integration or replaying the story in a person's mind and using it as a topic of discussion. Broadbent (1977) noted that people will often selectively attend to news which is relevant to them at a given time which may satisfy the resolution of ambiguous situations. Thus, people display distinctive information-gathering strategies which are dependent upon the need for "orientation" or "gratification" of the individual (i.e., stress reduction).

The media can set the agenda for news content and coverage; however, the information-gathering needs of the people will often determine the success of the agenda-setting strategies of the media. How the media influences the "salience" of an item can have important public health implications.

Media influence. Quite often the meaning of articles extracted from content depends on what the viewer brings to the situation from personal experience (i.e., mental availability model) (Graber, 1989; Slovic et al., 1974). Journalists rely on the stored memories of everyday events to help supplement news reporting and normalize a situation. A potential problem with tsunami risk perception is that few people have images of tsunamis stored in their memories from actual experience. Without personal experience with a low probability event many people are unable to fully appreciate the threat a tsunami will have on their safety or in eliciting appropriate adaptive behaviors to minimize the potential threat to their lives (Sorenson, 1983). This lack of experience is was especially evident during the "non-event" tsunami which occurred in 1986.

The tsunami alert of May 7, 1986 revealed flaws in the Hawaii State Emergency Broadcast System (EBS) in broadcasting an automated civil defense message tsunami warning (Dudley & Lee, 1988). The EBS had no regular testing procedure prior to this incident which could have resulted in increased fatalities if a destructive tsunami has indeed actualized. Radio disc-jockeys added to the confusion by giving often unofficial and inaccurate "great wave" activity. This clearly pointed to the need for faster, more efficient media involvement in natural disaster warnings. It should be noted that both the PTWC and the ATWC, however, had acted wisely and prudently in issuing a tsunami warning (64 minutes after the seismic event of the Coast of Alaska) (Dudley & Lee, 1988).

Most residents, tourists and workers in inundation zones did evacuate as ordered by Civil Defense authorities. However, as stated previously, when the federal, state and private organizations dismissed their personnel early, a gridlock occurred in the city of Honolulu (Dudley & Lee, 1988). Ironically, many of the people caught in the massive traffic jams were on roads which were within inundation zones. Obviously, a breakdown in communication and disaster planning had occurred which could have threatened hundreds, if not thousands, of people.

On the first business day of each month the tsunami early warning system is activated by Civil Defense authorities to test the effectiveness of the system. In the advent of an actual tsunami, a three minute steady siren tone will warn the populace to this threat. The public is informed, via the media, to consult the Hawaii telephone directory. In each telephone directory white pages there are maps which delineate, not only inundation zones for the Hawaiian shoreline, but also civil defense shelters in case evacuation of the public is required, as well as tsunami preparedness activities (Cox, 1979). The obvious question arises as to whether all residents of Hawaii have telephone directories and how many people are unable to understand standard American English.

Before the Tsunami Early Warning System was installed in 1948, "false alerts" of potential tsunamis were a common occurrence. This situation often leads to a desensitization of the public to respond to subsequent alerts which can have public health implications (Slovic, 1986). Likewise, if the public is reminded too often via the media of nonsalient - low probability natural or technological disasters, a "boredom effect" will trivialize the threat to the public's health should an actual disaster occur (Neuman, 1990).

Obviously, the media has an important role to play in setting the agenda of issue saliency, as well as providing the public with informative and timely information concerning the issue of interest (Wallack, 1990). The media can react to events either proactively and/or reactively. Those charged with protecting the public's health should be aware of how the media relates risk perception information to the public. An analysis of the categories of risk perception which are presented by the media to the public should be explored. Any obvious omissions of pertinent risk perception categories should then be identified and incorporated into future media articles with the ultimate result being better public education to a hazard which may threaten the health and safety of the individual and community. Thus, the media will be effective when communication about issues which help set the agenda of interest are increased, if threat is established, and if the messages facilitate efficacy.

Data-gathering processes. Sorenson (1983) observed that how people acquire information about low probability natural disasters which will impact society is not fully understood or documented and appears to be as fragmented as is the efforts and attempts to disseminate appropriate information. Awareness of a natural hazard does not automatically mean that an individual will exhibit adaptive behavior to counter the threat to their safety from the low probability event (Sorenson, 1983) Apparently, experience has consistently explained adaptive responses to low probability natural hazards regardless of the effort to remove the "prison of one's experience" through educational means (Kates, 1962; Sorenson & White, 1980). An analysis of newspaper or periodical articles over a period of time can serve as a source of information to help determine public concern for a particular issue; however, these analyses are often an indirect measure of concern (Loewenstein & Mather, 1990).

McCombs (1994) states that the "need for orientation is based on the psychological assumption that individuals who are in an unfamiliar situation will be uncomfortable until they orient themselves" (p. 14). Various researchers in health-related research have noted that individuals receive information from either interpersonal (friends, family, and doctors) or the media (print and electronic) (Freimuth, 1987; Mettlin et al., 1980; Simpkins & Brenner, 1984). Freimuth et al. (1989) noted that "although the mass media are the primary sources of health information, a detailed survey of media content revealed that the popular media, such as newspapers, contain little prevention information" (p. 747). Johnson and Meischke (1991) studied the communication channels employed by women for cancer information noted that individuals prefer channels which are interpersonal and/or authoritative. Communication researchers have noted that people are active information seekers and initiate media selection which are contingent upon various information sources (i.e., the interpersonal relationship between the individual and the source of information, access to information, immediacy of needed information and evaluation of information sources) (Freimuth, Stein, & Kean, 1989; Lenz, 1984). It would be interesting to determine what effect the "electronic highway", via electronic mail (e-mail), and the World Wide Web (WWW), will have on information seeking behavior. Obviously this is an area in need of future research.

The previous research on data-gathering mechanisms was concerned with health-related matters; however, do these models apply to non health-related issues? How does the media inform the public, both directly and indirectly, as to the risks associated with tsunamis and of the protective measures to be taken to safeguard health and safety? What are the communication channels which people employ to help fulfill their desire to "gratify felt needs" and initiate media selection to fulfill these needs (Katz et al., 1973; Rubin, 1986).

Thus, newspaper articles, or news broadcasts, concerning tsunamis often inform the public of the scientific processes which underlie this natural event. Whether tsunami-related articles are primarily or secondarily produced (i.e., piggy-backed onto other natural or technological hazards), the media can be a useful component of Civil Defense disaster mitigation strategies. Media coverage of low probability natural hazards which do not address why some people will deliberately or inadvertently place themselves at risk during these events will not fully help those charged with protecting the public's health to minimize unnecessary morbidity and mortality consequences. Information such as how many articles are concerned with general tsunami information (theoretical tsunami, educational), specific tsunami information (actual tsunami), human interest stories, the tsunami warning system, legislative concerns and statistics (morbidity, mortality, monetary concerns) would be helpful to determine the number and kinds of articles covered by the newspapers. Additionally, an analysis of newspaper articles which covered the tsunamis of 1946, 1952, 1957, 1960, 1964, 1975, 1986 and 1994 can help determine which risk perception categories were presented to the public (i.e., voluntariness of risk, immediacy of risk, tsunami knowledge by science and/or government, religiosity/spirituality, risk to future generations, cost to future generations, changes in risk, familiarity of the risk, dread of the risk and catastrophic potential). Therefore, determining what information the media disseminates concerning the risk perception of tsunamis could help in formulating proactive agenda-setting strategies by the public health and Civil Defense communities.

Risk Perception Theories and Communication

This section will explore various global theories of risk perception. Following this review, the pertinent literature concerned with the human experience with tsunamis and its influence on risk perception will be explored.

Risk perception theories. Risk assessments are employed by the scientific community to determine the risk to the public from both technological and natural hazards. Very often risk analysts and policymakers in regulatory agencies are unable to effectively communicate these risks to the public (Chapman & Lupton, 1994; Keeney & von Winterfeldt, 1986). Slovic (1993) determined that the lay public primarily relies on intuitive risk judgments (i.e., risk perceptions) from information received from the media to determine the risk from a particular hazard. Pararas-Carayannis (1983) noted that "hazard perception by the public is based on a technical understanding of the phenomenon at least at the basic level and behavioral response based on the understanding of the phenomenon and the confidence of the public for the authorities" (p. 6). Likewise, Keeney and von Winterfeldt (1986) have discovered that risk information, received from risk analysts and policymakers in regulatory agencies are often held in suspicion by the public, which contributes to the problem of effective risk communication. Those responsible for formulating risk assessments very often minimize or ignore the importance of risk perception when determining a quantitative estimate of risk. The problem of communicating risks from technological and natural hazards to a skeptical public has drawn the attention of many researchers who have explored the concept of risk perception from various social science disciplines such as geography, sociology, anthropology, political science and psychology. Risk perception research has explored how individuals behave during a technological or natural disaster, the social and cultural forces which influence an individual's understanding of a hazard, and what mental strategies or heuristics people employ to define an uncertain environment (Burton & Kates, 1964; Douglas, 1966; Freudenberg, 1988; Kahneman et al., 1982).

Fischhoff et al. (1978) developed a psychometric paradigm, which quantitatively measured perceived risk perception, perceived risk benefit and other components of perception. The quantification was accomplished by utilizing psychophysical scaling methods and multivariate analysis to demonstrate useful risk perceptions and attitudes (Slovic, 1986). Factor-analytic methods, which developed from previous psychometric "personality profile" studies can graphically plot the quantitative risk values which subjects had given to various hazards on a factorial map (Fischhoff et al., 1978). These values represent a "cognitive map" of an individual's risk attitude and perception (Slovic, 1987). Thus, quantitative methodologies can now hierarchically place tsunamis and other natural or technological hazards according to the public perception of risk from these hazards.

Most of these psychometric studies were primarily concerned with technological hazards, whereas very little research concerned natural hazards (P. Slovic, personal communication, January 3, 1995). However, following Hurricane Hugo (1989) and Hurricane Andrew (1992) natural hazards and risk perception studies have generated some interesting observations (Bandoroff et al., 1993; Saylor et al., 1992; Smith & Belgrave, 1994). The disastrous impact which these hurricanes have had on life and property has sensitized local residents, as well as the American public, to the destructive potential these storms can produce. Hurricane Andrew, which impacted the southeast of the United States in 1992, temporarily destroyed the "taken-for-granted" reality of every day life and imposed the natural environment on the residents of Dade County, Florida. Everyday life in Dade County, Florida was shattered by the awesome strength of this hurricane and would not resume normality for many months or years post impact (Smith & Belgrave, 1994).

Slovic et al. (1985), using principle component analyses, revealed that particular cognitive risk perceptions which people hold about natural and/or technological hazards will influence their protective adaptive behavior. Some of these perceptions are whether or not an individual dreads or not dreads a particular hazard, its threat to future generations, the potential global catastrophe resulting from the risk and a perceived inequity of egalitarian risk assumption. These characteristics are highly correlated with perceived risk, adjusted risk and risk regulation. Other measures of risk, such as voluntariness, immediacy of effect, knowledge, newness, severity of consequences, reversibility, control, exposure, familiarity, and observability also correlate with perceived risk and risk regulation but to a lesser extent (Slovic et al., 1985).

Fischhoff et al. (1972) demonstrated that every hazard has a characteristic set of qualities which is related to its perceived risk. Many of the qualitative risk characteristics were also found to be correlated with each other (e.g., "voluntariness" was perceived to be both "controllable", as well as "well-known" and those hazards which appear to threaten future generations were seen to have catastrophic potential, etc.) (Slovic et al., 1985; Slovic, 1992). Risk assessors who depend on absolute statistical probabilities, without taking into account how the individual or public will respond to a particular hazard, will fail in their attempt to provide comprehensive analyses of the risk posed to both the individual and society by a particular hazard (Baker, 1990). Many researchers have studied how people perceive the risk from either natural and/or technological hazards and have identified certain personality types, and the concomitant adaptive mechanisms which individuals employ to understand an unpredictable world (Alexander, 1991; Bell et al., 1984; Downs, 1972; Drabek & Stephenson, 1971; Schiff, 1977; Simpson-Housley, 1979; Slovic 1987, 1992, 1993a; Turner, 1976; Witte, 1992).

Bell et al. (1984) describe several factors which researchers have discovered influence the risk perception of natural hazards such as the "crisis effect", the "levee effect" and "adaptation effect". These factors describe the pre and post disaster behavioral adaptations which people employ to lessen the cognitive discomfort resulting from living in a world continually in flux. For example, the crisis effect refers to the public's increased response to a disaster during and following it's occurrence with interest dropping off rapidly between disasters. Following a disaster, there may be an increased interest to study the phenomenon, but interest will steadily wane if the disaster is not reinforced repeatedly (Alexander, 1991). The levee effect relates to the increased perception of safety when structural mitigative measures have been instituted to decrease the threat to the population by natural disasters (Bell et al., 1984). It must be remembered that many mitigative activities are based on projected figures of potential impact which may, in fact, vary with each natural disaster. The normalization of risk from a potential hazard where the population-at-risk will "learn to live with it" is known as the adaptation effect. Burton et al. (1964) state that the public tends to force probabilistic occurrences into deterministic patterns which tend to "ease the psychic discomfort that random natural hazards have on the public's perception of risk." Thus, the public will often normalize the threat and propose that the hazard has a periodic or predictable pattern (e.g., "We have tsunamis every few years"). This stress-reducing mechanism often helps the individual comprehend an unpredictable environment. An obvious question which will help determine the risk perception of tsunami is to explore how often people think tsunamis occur in Hawaii and in the world. These perceptions are often subject to individual life experiences which may or not reinforce positive adaptive behaviors to help prevent unnecessary health and safety consequences.

Risk perception is influenced by a number of biases which prevent people from adequately assessing actual risks. White (1972) discusses "bounded rationality" in which the individual selects among a choice of options which is limited by his or her perception of the hazard in question. This "theater of one's experience" will often prejudice the comprehension of a hazard by the individual or society (Leviton, 1991; Sorenson, 1983; Wright & Rossi, 1981). The scientific community and those decision makers charged with protecting the public's health (i.e., policy makers, legislators, public health educators) are responsible for educating the individual and society to the risks posed by either natural or technological hazards. The purpose of this process is to remove the "prison of experience" which influences most people's perception of risk from potentially harmful hazards (Kates, 1962; Sorenson, 1983).

How people respond to a natural hazard or disaster, either individually or societally will depend on their previous expectancy experiences. Expectancy is defined as the probability held by the individual that a particular reinforcement will occur as a function of a specific behavior on his/her part in a specific situation or situations (Rotter, 1954). What would be the consequences of risk-taking behavior which elicited no deleterious outcomes following a "nonevent" disaster. For instance Rotter (1966) states that "specific expectancies regarding the causal nature of behavior-outcome sequences in different situations would also affect behavior choice" (p. 2). Thus, did the two mini-tsunamis of 1986 and 1994 diminished the need for positive adaptive behaviors to the threat of approaching tsunamis especially when the need for such behavior has not been adequately reinforced by experiencing deleterious consequences to life and property?

Hazards which are viewed as being easily controllable elicit less negative risk perceptions than if the risks were considered to be noncontrollable (Slovic, 1986). Ironically the risk perception of the layman may not reflect the same level of concern by the scientific community (Fischer, et al., 1991). Various researchers have explored the personality types which explain how an individual "views" the world (Fromm, 1941; Heider, 1958; Kelley, 1971, Palenzuela, 1988; Rotter, 1966; Simpson-Housley, 1979). These authors have shown that locus of control personality measures and repression and sensitization measures can help explain why some people may view relatively minor risks as being major and vice versa.

Locus of control personality measures categorize individuals as having an external or internal perception of the world when they are confronted with potential harmful stressors (Heider, 1958; Rotter, 1966). Simpson-Housley (1979) studied the two dimensions of locus of control personality measures and repression-sensitization in relation to earthquake hazard perception in Wellington, New Zealand.

Simpson-Housley (1979) noted that individuals who exhibit an "external locus of control" personality type tend to see the world as "beyond a person's control" (fatalists). Palenzuela (1988) further differentiated this category to include unpredictable random factors such as luck, fate and chance and also control by powerful others. Fromm (1941) notes that individuals who exhibit an <u>external locus of control</u> personality type seek power and control through something outside the individual which possibly compensates for the feeling of powerlessness in the person's life. Kelley (1971) notes that people apply causal events and attributions to help explain events as a way in which people can come to terms with and possibly control their world. Kelley (1971) further states that people attribute to controllable sources those situations in which we desire the gain the most control; however, this control may be real or only an illusion.

Individuals who exhibit an "internal locus of control" personality type often respond to the stressors of the world as being "contingent upon one's behavior" (determinists) and perceive that they control the probability of gaining positive reinforcements (Rotter, 1966). Bandura (1977) observed that expectation of competence is also necessary for an internal locus of control personality type. Miller and Norman (1979) discuss the issue of "learned helplessness" which is influenced by our ability or inability to enact change, emphasis on general rather than specific causes of cognitive discomfort and an internal locus of control. Simpson-Housley (1979) noted that individuals who possessed an internal locus of control personality tended to seek more active preventive and mitigative responses to potential earthquake hazards, while those who exhibited an external locus of control personality demonstrated a tendency to intimate active reparative responses possibly because they felt more helpless in the wake of this natural disaster.

This research will explore the sociodemographic influence on locus of control personality measures (i.e., gender, age, income, education, race and or ethnicity, and religion). Also, will people assume an internal or external locus of control personality measure in the event of a tsunami by either assuming personal responsibility for their health and safety or by indicating that an "authority figure" (government) should shoulder the responsibility?

Repression-sensitization measures are types of defense mechanisms used by individuals to avoid anxiety arousing stimuli. "Repressors" deal with stress through denial, repression and rationalization to control a threatening stimulus while "sensitizers" control anxiety through intellectualization, obsessive compulsive behavior or through ruminative worrying (Simpson-Housley, 1979). Simpson-Housley (1979) noted in their study that the defense mechanisms employed by both repressors and sensitizers underestimated the threat from seismic events which was evident in their lack of preventive action.

Locus of control personality measures can be indirectly explored by determining who is ultimately responsible for protecting the health and safety of the individual if or when a tsunami threatens the Hawaiian Islands. Should the individual be responsible for his own health and safety or should the government protect people from tsunamis? Simpson-Housely (1979) state "individuals differ according to whether they consider environmental consequences predictable and hence controllable or whether they consider they are random or fate determined" (p. 14). Whether or not people feel they can avoid injury or death should they be impacted by a tsunami can also indicate their locus of control personality measure. Interestingly, Simpson-Housely (1979) also notes that those individuals who exhibit an external locus of control personality measure can be influenced by their perceived "inability to confront the threat, but also could be influenced by a possible higher expectation of the threat" (p. 15). The author also states that those individuals who express an external locus of control personality measure can be influenced to adopt a more internal locus of control measure by giving explicit instructions to "externals" for adaptive behaviors which are linked to successes which have been achieved in the past. Simpson-Housely (1979) also states that if "greater internality is achieved, the perceived ability to cope with obstacles would also increase" (p. 23). Interestingly, very few studies have explored the effect of religiosity/spirituality on risk perception. Jessor, et al. (1968) noted that Spanish-Americans tended to exhibit more external locus of control personality measures than Anglo-Americans. Similarly, Bauman and Sims (1974) in a study examining the attitude of predominantly Roman

Catholic Puerto Ricans with other United States citizens toward their views on success in the world noted that Puerto Ricans exhibited an external locus of control personality measure, whereas, United States citizens exhibited an internal locus of control measure. Since so few studies address this issue, this research will explore whether or not religious preference influences survey participants' risk perception of tsunamis.

Rogers (1983) delineates protective motivation behavior as consisting of threat appraisal and coping appraisal. Becker et al. (1977) proposed the Health Belief Model which emphasizes the individuals' subjective assessment of vulnerability or likelihood of experiencing the threat with the outcome or extent or severity of the threat. The authors note that threat assessment is subject to both intrinsic and extrinsic rewards which may prevent protective adaptive behaviors. Coping appraisal determines the response efficacy which is the subjective assessments of the effectiveness of the recommended action, self-efficacy which is the individuals' ability to accomplish the action and barriers or response costs involved in doing the action (inconvenience, etc.) (Rogers, 1983). For example, the evacuation procedures following the 1986 mini-tsunami resulted in massive grid-lock and needlessly jeopardized many people who were "stuck" within inundation zones. A positive response efficacy is necessary for protective adaptive behaviors or coping responses. The media may have communicated the helplessness of people if threatened by tsunamis by broadcasting information concerning the ineffectiveness of the evacuation process. This information may have negatively influenced people to instigate positive adaptive behaviors by reinforcing the low response efficacy of taking these protective actions. Likewise, if people presented with messages of high susceptibility and high severity are presented images of grid-lock then people will respond to this lack of response efficacy by dealing with fear rather than danger. By reporting that there was a "party-time" atmosphere surrounding this mini-tsunami the media may have inadvertently communicated a lack of threat to the health and safety of the populace.

Therefore, judging the efficiency of appropriate positive adaptive responses may have been compromised until the next destructive tsunami to impact the Hawaiian Islands.

Bandura (1977) further delineates the sources of self-efficacy as performance accomplishments, emotional arousal, verbal persuasion and vicarious experience. Personal experience rather than vicarious experiences coupled with the confidence in the individuals' capacity to perform the behavior in question results in feelings of personal mastery which are consequently effective in producing threat-coping adaptive behavior (Bandura, 1977).

Leviton (1991) states that individuals will more likely take protective measures for minor threats which are highly probable than for potential major events of low probability of occurrence. The "mental availability concept", proposed by Slovic et al. (1974), explains how an individual and society will respond to a hazard according to the recency of exposure (experience) to a hazard and the emotional saliency of the event. The "myth of invulnerability" further erodes protective adaptive behavior by deluding the individual that accidents do not happen to them but rather more to others (Leviton, 1991). Leviton (1991) further states that the more we have experiences which are not threatening the more we believe we are invulnerable. This perception produces possibly destructive illusions of "overconfidence" (i.e., the perception that the individual can effectively cope with a threatening situation without taking into consideration the magnitude and lack of experience coping with major threats). Leviton (1991) notes that when self-efficacy is not routinely questioned, and the time intervals between threats is great, then our capability to cope with a threatening situation may be compromised which may lead to inappropriate risk taking behavior. Therefore, how much the individual feels he can control his or her own fate could have public health implications. Whether or not individuals initiate positive adaptive behavior strategies may depend on their personality types and how they view the world.

Slovic (1986) describes the "signal potential" or "informativeness" which a natural or technological disaster will have on risk perception. Disasters or hazards which take many lives may oddly produce little social impact (beyond family) if they occur as part of a familiar system, while a small accident which is not part of a familiar system can have immense social implications. Additionally, Burns et al. (1993) described this phenomenon as the "social amplification" of risk. In other words, a relatively minor adverse event may have far reaching indirect consequences not directly related to the adverse event. One such example is the risk perception of the nuclear industry following the Three Mile Island and Chernobyl nuclear-reactor accidents (Slovic, 1993). Burns et al. (1993) developed structural models which help illustrate how such attitudes are formed by the physical characteristics of the event, perceived risk, media coverage and public response. The findings of these researchers reveal that both the media and public response play an important role in how an adverse event is perceived by the public. If the adverse event was perceived to be of managerial incompetence (e.g., Three Mile Island, Chernobyl), a social amplification will take place because it signaled future risk from unsafe technology, as well as risk to future generations.

It would be theoretically interesting to postulate if a highly destructive tsunami would produce enough "signal potential" to elicit a cognitive appreciation of the local and global catastrophic consequences which this natural hazard can inflict on low-lying coastal communities. Specifically, how often do people think tsunamis happen in Hawaii and around the world? How can this potential be translated into social awareness with a concomitant increase in risk perception which this hazard can pose to the residents in coastal communities? A baseline understanding of how people view the catastrophic potential of this hazard may be valuable in future research should the Hawaiian Islands be impacted by a destructive tsunami in the future. This research could possibly reveal flaws in public comprehension of probability statistics and the need for better risk education from those charged with protecting the public's health.

Kates (1962) noted that individuals have an inadequate perception of randomness when applied to a natural or technological hazard. This faulty perception is often termed the "gambler's fallacy". For example, people who have experienced floods believe they are less likely to occur in year x +1 if one had occurred in year x. This negative recency effect can best be illustrated in the popular concept of a "100 year flood". People estimate that once a 100 year flood has occurred then it will not re-occur for another 100 years. Unfortunately, it is not possible to predict when the next flood will occur. Thus, a false sense of security will result when people try to normalize a distressing situation into an understandable probability. Perhaps this misperception of risk can best be addressed by better education utilizing appropriate and understandable language.

Similarly, Alexander (1991) describes a "magnitude frequency principle" where frequent events are easier to remember than infrequent events, just as events which are likely to occur rather than unlikely to occur (e.g., snow in December in the Northern Hemisphere) (Slovic et al., 1974). The "Law of Inverse Magnitude" states that the further one progresses from the signal event (i.e., memorability), the psychological and emotional impact will decrease unless death, destruction and other losses increase proportionately (Turner, 1976). How individuals cope with situations of either immediate or delayed threats will influence the formation of protective adaptive behaviors.

Slovic (1985) notes that an "immediacy of threat" will often influence the risk perception of individuals. Will people adopt different positive adaptive behaviors if they comprehend that they are in immediate threat or would they delay taking these actions if they thought the threats would occur in an unspecified period of time in the future? Do people fear tsunamis when they are at the beach enjoying water related activities (i.e., swimming, surfing, boating, diving, fishing)? Do people think about tsunamis when they are driving to or from work? Do people who reside within inundation zones consider themselves to be at risk should a tsunami alert be sounded? What kinds of protective behavior would residents of low-lying coastal communities take to secure their health and safety should a tsunami alert be sounded? How responsive are people to readily evacuate their homes within low-lying areas should a tsunami alert be sounded? Conversely, should they decide not to evacuate their homes does society have the right to forcibly evacuate those people who do not elect to evacuate and knowingly place themselves in danger? All of these questions can possibly be linked to the perception of how immediate the risk of a tsunami can impact their lives.

Interestingly, Wright and Rossi (1981) discovered that society has a tendency to export nonsalient risk onto future generations, whereas the individual will often try to avoid this exportation when their descendants are personally involved. It appears that society will impose conservative risk reduction measures when the risk is perceived to be highly salient and of an unknown or uncertain nature while the reverse is true for nonsalient hazards. It would be interesting to determine what steps people are willing to take to secure the safety of future generations from the threat of tsunamis. Would these steps include allowing civil defense authorities and law enforcement officials the ability to forcibly evacuate people from know inundation zones should a tsunami alert be sounded? Do people feel it is important to protect the safety, as well as reduce the cost to future generation by limiting construction within tsunami inundation zones?

How much an individual will dread or not dread a natural hazard depends on the perception of the possible impact the hazard will have on their personal safety (Savage, 1993; Slovic, 1987; 1993). Slovic (1987) suggests that the more novel a hazard is to the respondent's mental availability model, the greater will be the dread of the hazard even if the actual versus potential risk from the hazard is controversial. Preston et al. (1983) discovered that the public will often overestimate the impact from a disaster or sensational hazard and underestimate the impact which a more pervasive hazard will have on a small number of victims each time they are exposed. How the threat to health and safety of the individual from natural hazards are presented to the public will often have an impact on whether or not positive adaptive behaviors will be employed. Therefore, an obvious question which should be explored in this research is whether or not people fear tsunamis, as well as how much they worry about tsunamis as they go about their everyday lives. The results of this question will aid the public health and Civil Defense communities in addressing both hyper and hypovigilance in response to this natural hazard. However, addressing the risks to health and safety which this hazard may pose to the populace should be presented with great care as illustrated by the following studies.

Lopes (1992) tested the effect of risk perception and disaster preparedness by utilizing disaster damage images of tornadoes, earthquakes and floods during presentations given by the American Red Cross. The sample (n = 4739) consisted of individuals who resided in tornado, earthquake or flood prone areas of the United States. Two different sets of slides were alternated to determine the effect of disaster images on the public perception of risk from natural disasters and consequent preparedness. One set of slides contained graphic depiction's of disaster images and the other set contained no disaster images, but contained the "right thing to do" to prepare in advance for natural disasters. A six month follow up interview was conducted to determine the effectiveness of each presentation and concomitant effect on disaster preparedness. The study revealed that when disaster images were used in the presentations rather than heightening the public's response to the risk of natural disasters it actually increased avoidance and denial (100%). This finding contradicts the availability hypothesis as proposed by Kates (1962), which states that any factor which makes a hazard highly memorable either through experience or vivid film or lecture could conceivably increase the perceived risk of a hazard.

Lopes (1992) also discovered that those respondents who viewed a presentation which did not include disaster damage images exhibited apathy toward preparing for disasters (78.1%) followed by avoidance (11.3%), denial (5.2%), myth (3.4%) and mixed responses (myth, misperceptions and apathy) (2.0%). However, the author postulates that when the public is not shown disaster images, but the "right thing to do", they will feel better prepared to deal with disasters and possibly take proper precautions in advance of a disaster. Goffman (1971) noted that when people are confronted with uncertainty, avoidance and denial strategies will help people master the experience. Denial helps people distance themselves from an event; this may help them overcome overwhelming environmental or psychological stimuli.

Witte (1992), researching the role which threat and efficacy plays in Acquired Immune Deficiency Syndrome (AIDS) prevention developed the "Equal Parallel Process Model" (EPPM). In this model the author discusses that threatening messages (written or verbal) can motivate behavior change if the message is accompanied by a response which is considered effective and acceptable. Conversely, if the message content is high in fear and threat, and the mechanisms in which to minimize the threat is low or ineffectual, then the individual will minimize the threat through "defensive avoidance processes" (Witte, 1994). Witte (1994) also suggests that those responsible for message content should include effective and feasible prevention strategies to maximize the message effectiveness.

Thus, various risk perception theories have been presented which may explain if, how and why people respond to natural and/or technological hazards. These research theories have greatly increased the understanding of how people perceive and respond to risk from natural or technological hazards. There have been many more studies directed toward studying individual or societal risk perception of technological rather than natural hazards. Very few studies have directly explored risk perception and evacuation procedures in relation to tsunamis. Most notably the work done by Lachman et al. (1961), Havinghurst (1967), Drabek and Stephenson (1971), Haas and Trainer (1973), Saarinen and McPherson (1981) and Sorenson (1983) have explored risk perception and human behavior during tsunamis, floods and/or landslides.

Following the May 23, 1960 tsunami in Hilo, Hawaii, Lachman et al. (1961) conducted a quasi-random sample of the adult residents of the inundated areas (n = 327). The study examined the subjective interpretation of the tsunami warnings and the consequent behavior of the residents who had experienced this tsunami. The authors noted that the residents' behavior could be classified into three distinct groups: the "do-nothing", "wait and see" and "evacuate" groups. The do-nothing group, which comprised 15% of the sample, did not respond to the impending tsunami. The wait and see respondents (56% of the sample) prepared for the impending disaster but decided to wait for further instructions or information. The evacuate group (29% of the sample) took immediate protective action to minimize their risk from the tsunami. The risk perception of these groups differed dramatically from one another. The 15% of the sample which did not evacuate felt they were in a safe area and not directly threatened by the tsunami. The wait and see group perceived the risk from the impending tsunami by making preparations for evacuation but waited for further instructions to evacuate. The 29% of the sample which evacuated perceived the risk form the tsunami as affecting their personal safety and decided to "play it safe". Most of the respondents had been informed of an imminent tsunami well before the siren was sounded through various communication channels (i.e., radio-TV[68%], relatives-friends [17.2%] and radio-TV and relatives-friends [8.4%]). The other 6.4% heard of the tsunami through governmental sources (police, firemen and civil defense) and in combination with government, relatives-friends and radio-TV sources. The authors state that formal education is not a determinant of whether or not an individual decides to take precautionary behavior by evacuating or staying awake during an impending disaster. This study also determined that those individuals with previous experience with a tsunami slightly increased (9%) the probability of adaptive behavior in later emergencies. Interestingly, approximately 69% of the 29% of the people who had evacuated were of Hawaiian or part-Hawaiian ancestry. It would be interesting to postulate if the evacuation response of Hawaii's indigenous population was the result of an elaborate Hawaiian or Oceania mythology linked with geophysical events and the detrimental consequences of inaction; however, an additional interpretation may be that they had survived and learned from the destructive tsunami which impacted the island of Hawaii on April 1, 1946.

However, the Lachman et al. (1961) study must be considered within the context that residents of Hilo apparently did not fully understand how the tsunami warning was to be given and how they were to respond. The researchers did query the residents as to their knowledge of the tsunami warning system, but failed to take into account that the system had been changed a few months prior to the May 1960 tsunami. The old system consisted of three siren warnings: the first of which represented a tsunami warning, the second indicated it was time to evacuate and the third was an indication that the first waves were about to strike the coast. This system was replaced by a one siren warning which meant that the populace was to evacuate immediately - no additional warnings would be issued. Many of the affected people were waiting for the second blast of the siren which unfortunately did not occur. Therefore, many of the conclusions which this study draws must be interpreted with caution.

Havinghurst (1967) studied tsunami hazard perception in selected sites on Oahu (Haleiwa, Makaha, Ewa Beach and Waimanalo) (n = 212). The author found that general knowledge of tsunamis (terminology and frequency) was not significantly different for each of the communities studied. Most of the respondents stated that they knew very little about tsunamis until the 1946 tsunami hit the Hawaiian Islands. Frequency expectations and subjective descriptions changed from site to site depending on length of residency and previous experience with tsunamis. The author noted that information concerning tsunami hazard perception was influenced by the neighborhood's experience with previous tsunamis. For example, the community of Haleiwa, which has been directly affected by tsunamis in the past, consequently, had a greater knowledge of tsunamis than the other communities. Surprisingly, the residents of Haleiwa were less apt to follow the advice of the technical experts and evacuate to safety. They had a wait and see attitude before they would evacuate and would remain in an inundation zone for as long as possible.

Sims and Baumann (1983) noted that prior experience with a natural hazard was sometimes related to adaptive behavior (i.e., evacuation, preparedness etc.). Availability bias and locus of control personality types apparently influence the individual's response to implement adaptive behavior strategies (Sims & Baumann, 1983). Likewise, Perry (1979) noted that a precise adaptive plan will be taken if the individual has had recent prior experience with a disaster. Apparently, the more detailed a warning message is the more likely it will stimulate effective adaptive procedures. Perry (1979) also noted that the greater a person's real threat (warning belief) that their health and safety may be affected by a hazard the more likely the individual will be to evacuate in a timely manner.

Drabek and Stephenson (1971) studied the effects of evacuation on 278 families who were evacuated prior to a catastrophic flood which occurred June 16, 1965, in Denver, Colorado. The authors described five analytical characteristics of this atypical flood; sudden onset, unexpected occurrence, unfamiliar experience, highly localized impact and varied social contexts of communication. These characteristics were described by Slovic (1987) as factors which influence risk perception. The researchers found that unless people were given a direct order to evacuate, they would automatically seek confirmation of the danger from other sources as to the necessity for evacuation. If the order to evacuate was given by the authorities, then the residents would evacuate immediately (61%). This type of confirmation of impending disaster was considered to be an “action provoking message”. The authors also discovered that although the news media was able to inform the most people of an impending disaster, it was not the most effective means of communicating appropriate responses to the event. Residents tended to ignore the media’s message, which they viewed as descriptive information and not orders to evacuate, and sought additional confirmation from other sources (i.e., friends, family etc.). The researchers revealed that the residents tended to disbelieve mass media messages and viewed them as inappropriate sources of information, whereas the message to evacuate given by authorities was considered to be an appropriate source of information. Families which were not separated at the time of the disaster tended to be less skeptical of the need to evacuate than those families which were at the time separated from one another. Those residents who failed to heed appropriate evacuation responses from either the authorities or mass media, demonstrated denial mechanism (i.e., it will not hit our house, etc.) and failed to instigate adaptive behaviors.

Drabek and Stephenson (1971) noted in their experiences with the floods which impacted Denver, Colorado on June 16, 1965 that evacuation of those at risk from a hazard will usually occur when all household members are accounted for and that the closer one’s relationship is with kin then the more likely it is that the individual will evacuate. Perry (1979) also noted that if people are fortunate enough to have a close extended family this will increase the number of credible (multiple) sources of warning information and that the more active an individual is in the community the greater the likelihood that the individual will formulate positive adaptive strategies and evacuate when faced with a life threatening hazard. However, families headed by aged persons, or extended family households containing senior citizens are less likely to evacuate in response to hazard warnings because the frequency of contact with other family members decreases as does the information coming into the family unit because of age often accompanied by a decrease in community participation (Perry, 1979).

Saarinen and McPherson (1981) studied the impact which a landslide warning had on the risk perception and evacuation plans of the residents of Kodiak, Alaska. The landslide warning had been issued by the United States Geological Survey (USGS) of the possibility of a landslide occurring on the face of Pillar Mountain (situated above Kodiak, Alaska). In 1964, the city of Anchorage, Alaska experienced a destructive seismic event which generated a tsunami (3.9 m) affecting Kodiak and nearby islands. The tsunami resulted in two deaths and property damage worth $25 million (Kachadoorian & Plafker, 1967). The 1964 seismic event also generated numerous landslides and avalanches throughout the state. A warning was issued for the city of Kodiak from the USGS that an earthquake could trigger a landslide from Pillar Mountain which would result in approximately 7.6 million cubic meters of material which could slide into Kodiak Harbor. A tsunami of approximately 3.05 m would be formed from such an event (Kachadoorian & Plafker, 1967). The authors interviewed the residents of Kodiak Island to determine their response to the USGS notification. The percentage of residents who have experienced natural disasters in Kodiak are higher than the national norm. The residents were found to be less fearful of natural disasters and were willing to accept the risk posed to their safety. The researchers discovered that this attitude, coupled with communication problems between residents and governmental officials, diminished the perception of risk which a potential landslide could have on their life and property. The USGS could not issue a probability of when a landslide would occur thus reinforcing the uncertainty posed by the threat in the minds of the residents. The community overwhelmingly preferred that the landslide event should have at least a 50% probability of happening before a warning is issued in order to prevent adverse psychological discomfort as well as economic impact on the business environment. Because the scientific community was unable to present the probability for the landslide to occur, the community felt they were unduly "stigmatized" by a report which could not definitively predict when disaster would occur. Interestingly, the threat of a tsunami generated from a landslide was considered to be of minimal importance or impact by both the public and officials or decision-makers questioned in this study. Therefore, a policy of non-action endorsed by decision makers to a potential hazard would diffuse the psychological and economic uncertainty of a low probability and high consequence event (Pratt, 1984).

Therefore, evacuation decisions are influenced by previous experience with a deleterious hazard, the status of the "warning-authority" and the cohesiveness and physical accountability of the family unit. Interestingly, very little literature has addressed the effect of educational programs in stimulating individuals to take protective adaptive behaviors in the event of a deleterious disaster. Studies conducted by Haas and Trainer (1973) and Sorenson (1983) have explored the effectiveness of educational programs to inform individuals as to the risk posed to their health and safety. The results of their investigations suggest that a previous experience with a deleterious hazard is the most effective stimulus in promoting protective adaptive behaviors.

Haas and Trainer (1973) conducted a study to determine the effectiveness of tsunami education programs in 1969-1971. The researchers studied four Alaskan communities to determine how residents perceive the risk from tsunamis and to determine the most effective way to relate tsunami education to effect change in risk perception. After identification of these communities risk perception, a "tailored" educational package was developed to correct erroneous misconceptions. A follow-up study was conducted after 18 weeks to determine the effectiveness of the tsunami education program. The authors determined that none of the educational programs resulted in significant changes in risk perception of tsunamis hazards (i.e., tsunami knowledge, reliability of the tsunami warning system and appropriate procedures to follow should a tsunami strike). However, the authors discovered that when personal contact or mass media approaches were utilized in educating the public to the hazards of local tsunamis, their risk perception of the severity of tsunamis was significantly enhanced. Most of the tsunamis to strike Alaska are however, locally generated. The authors have noted that short-term public education programs, no matter how intense or remarkable, do not have lasting effects on risk perception from tsunami hazards. This was also noted by Sorenson (1983) who noted that previous experience with a threatening hazard preempted all other attempts to promote adaptive behavior in the event of a natural disaster (e.g., educational programs etc.).

This observation was verified when a seismic event off the coast of Sitka, Alaska produced an earthquake measuring 7.3 on the Richter scale on July 30, 1972. Haas and Trainer (1973) estimated that approximately 61% of the residents of this city thought that a tsunami may have been generated from the temblor. Of these respondents a small fraction of the population took timely and appropriate measures to safeguard their lives. The authors further determined from topographic maps, location at the time of the seismic event and the time taken for most people to evacuate, that approximately 85% of the residents who reside in low-lying areas (below 15 feet above mean sea level) would have been killed or injured if indeed the temblor had been tsunamigenic.

Sorenson (1983) also explored the effects of information, education and knowledge on adaptive responses to a threatening situation (e.g., earthquakes, tsunami, hurricanes and flash floods) on 171 geography students at the University of Hawaii. Those individuals who had exhibited positive adaptive behavior in the event of a threatening situation were those individuals who perceived high levels of risk, were long-time residents, had an internal locus of control orientation, received (disaster) education prior to the hazard, experienced a previous disaster and were aware of the hazard. The reverse is true for those people who had not demonstrated a positive adaptive behavior prior to a threatening hazard. The relationship between educational processes and adaptive behavior to an extreme natural event could lead to more effective policy recommendations.

Sociodemographic Influences on Survey Respondents' Risk Perception Beliefs and Attitudes Concerning Tsunamis

Few studies have addressed the effects of sociodemographic influences on risk perception. Savage (1993) noted that 80-90% of the variation in risk perceptions across individuals is a matter of a person's character rather than pure demographics. However, Savage also noted that there are some consistent variations in risk perception which can be attributed to demographics. For example, women, ethnic minorities and people with lower levels of education and income have more dread of hazards. This study also noted that women tended to seek out more safety-related regulations than men and that people who have attained higher levels of education and income favor more pro-safety attitudes.

Similarly, Bord and O'Connor (1992) studying the risk perception of hazardous waste sites noted that women often make higher health risk estimates than men. The authors also noted that risk perception attitudes of laypeople often approximate those of the experts as the individuals' educational level increases and if they have a trust in government. Interestingly, while education achievement appears to be the best predictor of comparable risk estimates between laypeople and the experts it was not shown to be linked with concern. The authors also noted that those people with low trust in government do not make comparable risk estimates analogous to those of the experts but instead tend to perceive higher risks which translates into a more pronounced dichotomy of risk estimates.

Perry (1979) noted that, in general, younger people have higher dread than older people to hazards. These groups may be less familiar with the scientific complexities of the hazards and concomitantly less accepting of the risks. Savage (1993) disagrees with

Perry and theorizes that this is a result of personal exposure to a hazard more especially so in minority neighborhoods. Interestingly, the manufacturers of technological risks will often find older adult men will downplay the risks from their products while the reverse is true for women and minorities even though the risks are actually inverse respectively (e.g., pesticides in food, video display terminals, high voltage power lines, nuclear wastes and medical x-rays) (Savage, 1993).

Flynn et al. (1994) in a study which examined the relationship of race and risk noted that nonwhite males and females were much more likely to perceive environmental risks similarly, whereas, white males and females did not exhibit this tendency. Also white males differed in their perception and attitudes of risk from everyone else in this study (i.e., white males tend to view the world as far less "riskier" than women and members of other racial groups). The authors related this difference in risk perception to sociopolitical factors (i.e., power, status, alienation, and trust).

Therefore, how people perceive risk has been shown to be influenced by various sociodemographic variables. It would be interesting to learn if women perceive the risks to their health and safety from tsunamis differently than men. Likewise, does educational attainment, age, total family income, length of residency and religious preference influence how people perceive the risks from tsunamis? A delineation of how sociodemographic status influences risk perception should help those in the public health and Civil Defense communities identify those individuals who may be most at risk should a destructive tsunami impact their lives.

Communication Channels

This section will address various information channels that Civil Defense and people employ to impart or obtain relevant information concerning the risks that tsunamis pose to life and property.

Tsunami information channels. There is usually sufficient time to evacuate the public from known tsunami inundation zones to designated areas of refuge to prevent the loss of life. In the case of locally generated tsunamis, where time is of the essence, it is questionable if any warning system could effectively produce adequate results (Morgan, 1984) (see Appendix A, Table A3). However, even the best tsunami warning systems, for both distal and locally generated tsunamis, would be ineffective if the public does not fully perceive the risk which these waves pose to their safety. It is imperative that the public understand the tsunami warning system and know what protective actions should be employed in the event of a tsunami.

Some communities have instituted educational programs to help inform their constituents of their role in disaster preparation and mitigative activities. The Oahu Civil Defense Agency offers public education through the Speakers Bureau (see Appendix G). The Bureau will discuss civil defense strategies on a number of subjects such as the proper preparedness for tropical storms and hurricanes, disasters, tsunamis, earthquakes, as well as discussions concerning hazardous materials. The Speakers Bureau is, however, a passive outreach program which requires various organizations, such as civic organizations, church groups, schools, hotels etc., to request speakers on civil defense topics.

An active outreach program on tsunami and earthquake education was instituted by the State of Alaska in 1976 through the Alaska Department of Emergency Services (ADES) in co-operation with the Alaska Tsunami Warning Center (ATWC) and other hazard officials from the west coasts of Canada and the U.S. The outreach program plans at least one major trip a year to eventually reach those communities subject to these environmental hazards. The program, which is held every day of the visit, consists of three major briefings followed by a few minor briefings. This program briefs, in order of priority, disaster preparedness for the local public safety personnel, schools (staff and students), and the local media, if extant. Follow-up is accomplished by mail, telephone and the ADES sponsored regional seminars. In the event that a community was evacuated because of a false alert, the staff of the ATWC either visits or revisits the affected community to explain the tsunami warning process and stress the continued need for disaster preparedness (Sokolowski, 1991).

Some doubt may exist within the Civil Defense and public health communities as to the effectiveness of tsunami educational programs; however, as previously mentioned, the media can and often does inform the public as to hazard information. McCombs and Shaw (1994) examined which media seem to have the most significant agenda-setting effects (i.e., radio, television or print media). The authors discovered that television with its large audience to be the critical agenda setting agent when compared to radio and the print media. However, very few studies have directly examined the communication channels which people employ to gather information in preparation for or an impending tsunami. Research conducted by Havinghurst (1967), Lachman et al. (1961), Mileti and O'Brien (1992) has explored the communication channels which people employ to obtain hazard or tsunami information prior to impact.

Havinghurst (1967) noted that approximately 53.7% of the people he queried would consult the radio and television for tsunami information, followed by consulting the telephone directory (11.7%), contacting the police and fire department (11.1%), contacting Civil Defense (9.9%), other sources and don't know (13.6%). No mention was made concerning the proactive, or reactive, use of newspapers as possible sources of tsunami information.

Mileti and O'Brien (1992) note that people will often go through stages that will shape their risk perception behaviors. The authors call these stages the "hear-confirm-understand-believe-personalize-respond" sequence of risk perception behavior. This sequence consists of; hearing the risk information, confirming the warning, understanding the risk, belief in the accuracy of the information, cognitive and physical decisions as to what protective behaviors to institute, and responding to the risk by implementing protective adaptive behaviors.

Therefore, many different strategies have been explored by Civil Defense to impart information which may prevent unnecessary loss of life and property. The results of this effort have been less effective in eliciting long-term positive adaptive behavior than actual experience with a destructive tsunami. It would be interesting to discern what information-gathering and communication channels people employ to receive tsunami-related information. What media sources are most often consulted by people to access tsunami-related information? Is there a difference in the communication channels which people employ to obtain information regarding a theoretical versus an actual tsunami? What are the differences, if any, between the actions taken by people in response to a theoretical versus actual tsunami? And finally, what are the public health implications from the results of this inquiry?

Survey Participants' Cognitive Map of Tsunamis in Relation to 26 Natural and Technological Risks

Many studies have been conducted in the past few years which explored the risk perception attitudes between laypeople and experts in relation to natural and technological hazards (Brun, 1992). However, most of these studies have examined the more controversial hazards which are of technological origin, whereas, very few studies have explored the risk perception of natural hazards. Most risk experts are frequently puzzled by laypeople who are more concerned about minor risks but are rather indifferent to risks which pose greater threat to their health and safety (Burger, 1988). This disparity could be the result of experts who rely on statistical analyses of risks versus laypeople who take into consideration various subjective risk perception characteristics such as voluntariness, novelty, immediacy of risk, dread, fatality, control, catastrophic potential (Slovic, 1987).

Various cross-cultural studies conducted in the United States, Norway, Hungary, Poland and the former Soviet Union have noted that Americans are far more likely to express the highest levels of risk, whereas, people from the former Soviet Union have the lowest (Brun, 1992). The hazards often examined in these studies are concerned with habits (cigarette smoking and drinking alcohol), recreational activities (biking, swimming and mountain climbing), chemical substances (food additives, pesticides in food), nuclear technologies (nuclear waste, nuclear accidents) and societal problems (street drugs, motor vehicle accidents and crime and violence) (Brun, 1992). Slovic et al. (1985) explored which natural or technological hazards most concern people in their everyday lives and concluded that hazards which have a high probability and low consequence take priority over events of low probability and high consequence (Slovic et al., 1985).

As stated previously, most risk perception research examines technological, rather than natural hazards, which could be related to how well the hazards are known to the public. Natural hazards are often perceived to be both more familiar and better known to science than technological hazards which are often considered to be novel and highly threatening to the health and safety of the populace (Baum et al., 1983). Natural hazards are often perceived to be "acts of God" and "passively" imposed on us, whereas, technological hazards are often viewed to be produced by man and therefore capable of being involuntarily or "actively" imposed on us (Swanton & Maderthanes, 1976).

Couch and Kroll-Smith (1985) noted the difference in risk perception between natural and technological hazards as initially involving a "time dimension" which emphasized the cognitive difference in risk posed by these two types of hazard generators. Natural disasters were considered to be highly linear, ordered and possessing a clear reference point. Technological hazards, on the other hand, were considered to be less linear, nonordered and not possessing a clear reference point in which the community can state they are a community at risk or crisis.

However, since this research Couch and Kroll-Smith (1991) have postulated that "the real issue is not the quality of the disaster agent per se, but whether or not it significantly alters the relationships between a community, its built, modified or biophysical environments, and how people interpret and experience the changes in those environments" (p. 361). This concept is termed the "ecological-symbolic perspective" which takes into account that "people exist in exchange relations with ... environments and disruptions in the ordered relationships between individuals, groups and communities, and their ... environments, are labeled and responded to as hazards and disasters" (p. 361). This concept "encourages us to shift our view of (event sequences) from that of objective markers to subjective apprehensions of the place a person or group occupies in the disaster cycle" (p. 363). Clarke and Short (1993) have concisely summarized this concept as "the meaning is often found in the response" (p. 377).

Erickson (1990) postulated that toxic versus nontoxic hazards can be distinguished differently. Toxic hazards drive victims to use different interpretive frames in which to evaluate disasters. "Toxic contamination can make previously innocuous and often beneficial things such as the air we breathe, the water we drink and the sea and soil which nourishes the food we eat quite dangerous" (p. 120). Zerubavel (1991) noted that the physical damage and the cognitive boundaries of severe technological hazards are far more uncertain when compared with devastating natural hazards (i.e., Three Mile Island, Chernobyl, Bhopal, nuclear waste, nuclear weapons, etc.).

Fischer et al. (1991) noted that people's interests and concerns shift as their position in life changes (i.e., health and safety issues become more important as one becomes older). Many people interpret risk as potential threats whose likelihood of expression is contingent on the decision-maker's own actions and often worry about things that they cannot influence. For example, Fisher et al. (1991) surveyed undergraduate biology students to list as many health and safety, environmental and societal risks which personally concerned them. Environmental risks were most often reported to concern the students followed by health and safety and societal issues. The authors do acknowledge that their findings may be biased because of sampling frame issues.

Clarke and Short (1993) suggest that risk can be characterized by the "social construction of blame, the ambiguity in determining who the victims are and how much damage they have suffered and the probability that victims' grievances gain attention from organizations" (p. 379). The authors also noted that some toxic hazards are determined to be more toxic than others which is dependent upon who does the defining. Thus, theorizing blame is contingent upon "the circumstances in which blame develops, and understanding how institutional and organizational forces shape moral vocabularies of blame and distributions of power" (p. 379).

Thus, how people perceive the risks from natural and technological hazards is objectively and subjectively influenced by the expert and lay communities. Previous studies were concerned with distinguishing between natural and technological hazards; however, controversial contemporary research suggests that how a hazard, regardless as to its origin, impacts the social and physical aspects of a community will help shape risk perception attitudes. It would be interesting to determine how people rank both natural and technological risks in relation to how much they cognitively know and emotionally worry about a hazard. Which hazards are people concerned with as they go about their "everyday" lives? How are various natural and technological hazards ranked within and between the two categories? Are natural and technological hazards "clustered" according to categories such as habits, recreational activities, chemical substances, nuclear technologies and societal problems or do they exhibit a more "nonclustered" distribution in relation to other categories?

This literature review revealed very few tsunami-related articles in relation to risk perception. Most risk perception articles are concerned with technological hazards or technological disasters. Technological hazards, in comparison to natural hazards, elicit strong cognitive and emotional reactions from the populace because of the various risk perception factors as noted previously by many social science researchers.

An understanding of the factors which influence the perception of risk of tsunamis will have valuable public health and Civil Defense implications. What people "should do" versus "likely to do" in the event of a destructive tsunami will help those charged with protecting the public's health with formulating passive or active strategies to help eliminate or decrease morbidity and mortality consequences of this hazard. The relative paucity of tsunami-related articles may simply be the result of the low probability of this natural hazard. Unfortunately, it may take a highly destructive tsunami to increase the interest and support of those people at risk and the agencies designed to minimize that risk. The knowledge gained by this research may be especially valuable since pan-Pacific tsunamis will invariably impact the Hawaiian Islands. Thus, this research represented a unique opportunity to generate new knowledge concerning the various determinants which influence the risk perception of tsunamis in Hawaii. Hopefully, when the next destructive tsunami strikes the Hawaiian Islands, this knowledge will help prevent needless tragedies from happening.

CHAPTER 3

RESEARCH METHODOLOGY

Study Design and Methodology

This chapter will explain the study design employed in this research. The sample frame and selection process will be detailed, as well as any limitations which may interfere with the external validity of this study. The two research instruments developed for this research will be discussed in relation to the risk perceptions characteristics it was designed to examine. Data collection methods, preparation and processing of the information obtained by the research instruments will then be explained. This section is followed by a discussion of the statistical methodology utilized to analyze the data obtained from this study. An explanation of the creative variable definitions which were employed to "collapse" the variables for the Chi Square statistic will follow this section. This section is then followed by the methodology used to categorize and measure tsunami risk perception articles obtained from Hawaii newspapers (1900 to 1994).

Study population and selection process. An exploratory cross sectional survey of a random sample of the jury pool drawn from the adult population of the City and County of Honolulu was conducted. All potential jurors are randomly selected from a population that includes U. S. Citizens who are either registered voters (304,539), filers of Hawaii state income taxes (259,613), or holders of a Hawaii driver's license (593,383) in the City and County of Honolulu. Of those potential jurors who hold a Hawaii driver's license 40,000 individuals are randomly selected and an additional 40,000 individuals are chosen who are voters of the City and County of Honolulu and filers of Hawaii state income taxes (D. Koyama, Telecommunications and Information Systems Development (TSID), State of Hawaii Judiciary, personal communication, May 25, 1995). Approximately 10,000 jury summonses are undeliverable via the postal service and are consequently subtracted from those eligible to serve in the jury pool. This reduces the potential pool to

70,000 individuals. Those exempt by statute from serving on jury duty are attorneys, judges, firemen, policemen, residents on military duty, clergy, dentists, physicians and those who have served on a jury during the previous year, as well as convicted felons, residents under the age of 18, non residents, non citizens of the United States and those with an inability to understand English. English competency is determined by appeals made by potential jurors to the jury clerk or to the judge when chosen to sit on a jury. Omissions in the jury selection process utilized by the First Circuit Court in Honolulu include approximately 64,000 residents “in group quarters” such as those residents who are in institutions, correctional facilities, nursing homes, emergency shelters for the homeless, shelters for abused women, drug and alcohol abuse treatment homes, other people in group quarters, as well as military personnel, indigent people visible on the street and other noninstitutionalized people (1992, State of Hawaii Data Book). The total number of exemptions filed by individuals to not serve in the jury pool eliminates approximately 30,000 people from the sample. Therefore, a “surviving” jury wheel of 40,000 people each year provides potential jurors for the grand or petite juries of the First Circuit Court in Honolulu. From these 40,000 people 9,000 individuals will issued jury summonses sometime during the course of the year which comprise the jury pool. Approximately 200 to 300 potential jurors are summoned to appear at court each week which is contingent upon court trial schedules. (D. Koyama, Telecommunications and Information Systems Development (TSID), State of Hawaii Judiciary, personal communication, May 25, 1995).

Limitations of the selection process. According to a previous survey conducted by Ward Research of Honolulu, the jury selection process does not reflect the diversity of Oahu’s population (Van Dyke, 1985). This survey noted various skewed sociodemographic characteristics of the jury pool (see Appendix D). For example, people of Japanese or Caucasian ancestry are dramatically overrepresented on the juries. People of Hawaiian or part-Hawaiian ancestry are dramatically underrepresented as well as those of Korean, Filipino, and Samoan ancestry. Ward Research noted that the racial and ethnic distribution of jury pool candidates was skewed. This could be the result of non citizen exclusion of some of these groups in the jury pool. Van Dyke (1985) also noted that people over 35 are overrepresented while people under 35 are underrepresented - especially for the under 25 group of potential jurors. The median household income of this jury pool was found to be approximately 20% higher than the household income of the average Oahu resident, with people making $15,000 or less being dramatically underrepresented in the jury pool. Blue collar workers and farmers were also underrepresented. The educational level of the potential jurors was found to be overrepresented by college educated individuals when compared with the Oahu population as a whole. Individuals with a grade school education level were also underrepresented in the jury pool.

The survey conducted by Ward Research of Honolulu revealed some shortcomings of the jury selection process. However, the survey noted that the selection process of the First Circuit Court in Honolulu "is sound in most respects and is certainly carried out in a conscientious fashion by the court's jury clerks. Some disparities nonetheless exit between the jurors selected and the population-at-large and efforts should continue to find new ways that can produce panels that are more representative of our diverse population" (Van Dyke, 1985, p. 19).

The jury pool used for this survey consists of all individuals called to jury duty and not just those chosen to actually participate (sit) on a jury as was sampled by Ward Research. The demographic characteristics of the jury pool was categorized and analyzed according to gender, age, language spoken at home, marital status, presence or absence of children or elderly, educational attainment, total family income, length of residency, geographic distribution, religious preference, ethnic identification and race/ethnicity.

However, unlike the sociodemographic disparities of the selected jurors analyzed by Ward Research, the sociodemographic characteristics of the jury pool sample who voluntarily elected to participate in this research closely match the sociodemographic statistics obtained from the State of Hawaii Census of 1990 (see Appendix A, Tables A5, A6, A7, A8, A9, A10 & A11; Appendix B, Figures B10, B11, B12, B13, B14, B15 & B16).

Sample size and power analysis. Ghiselli et al. (1981) suggests that a representative sample size consisting of approximately 300 individuals (significance testing at a 0.05 level) will provide reliable estimates for the sample at 80% power. Cohen (1977) states that a nondirectional test, at α =.05 and power = .80, will detect moderately small differences between proportions (moderately small effect size is h = .40 and medium effect size h = .50) when split into at least three groups of about 100 each. The more desirable finite population correction (fpc) for this study is a proportion of 80/20 (including nonresponses [40,000-445/39,999]) which produces a value of 0.989, thus reflecting a representative sample size in relation to the random sample of the adult population of the City and County of Honolulu. The margin of error for this sample is 0.0378 ([0.16/445] $^{1/2}$ [1.96 confidence interval] = 3.71%) which is within 3.71% (95% confidence interval) of the sample size of 300 individuals. Therefore, the 3.71% sample error is far below the 5% "gold standard" noted for behavioral research (assuming 95% confidence) (Levy and Lemeshow, 1991).

Research instruments. Two risk perception questionnaires were developed by modifying instruments designed by Slovic et al. (1985) and Slovic (1993) (see Appendix F). The questionnaires were modified to determine; (1) how survey participants comprehend tsunami nomenclature; (2) which media are accessed to meet the tsunami information-gathering needs of the survey respondents; (3) the cognitive and emotional characterizations of survey respondents in relation to 12 risk perception categories;

(4) the sociodemographic influences on survey respondents' risk perception beliefs and attitudes concerning tsunamis; (5) the communication channels employed by survey respondents to a theoretical versus an actual Civil Defense tsunami warning; and finally, (6) the survey participants' cognitive and emotional map of tsunamis in relation to 26 natural and technological risks (see Appendix A, Table A13).

The reliability and validity of the questionnaire was determined by the use of the Cronbach Coefficient Alpha (α). A pilot test was conducted on 30 jury pool respondents to determine the homogeneity of inter-item risk perception questions. Confidentiality and anonymity of the research questionnaire was assured and stated in the cover letter which was attached to the questionnaire (see Appendix F).

The first questionnaire explores multiple indicators of risk perception (latent variables) and consists of 51 closed-ended questions which are measured either by a Likert Scale or with nominal classifications (DeVellis, 1991; Judd et al., 1991). The latent variable (risk perception) was analyzed according to thirteen risk perception criteria. Voluntariness of risk was estimated by using a two-item, five-point Likert-type scale and nominal scale which addressed individual responsibility issues. Each of the items was bounded by strongly agree/strongly disagree and yes/no scales. Reliabilities for these measures using Cronbach's coefficient for raw and standardized alpha levels were (α = .63 and .67, respectively). Ease of reduction of risk, was assessed by utilizing a one-item, five-point Likert-type scale and nominal scale which addressed risk reduction. This variable was bounded by a very easily/never scale. Newness of the risk was determined by utilizing a one-item, five-point Likert-type scale which addressed survey participant experience with tsunamis. This item was bounded a very new/very old scale. Knowledge about risk was determined by utilizing a three-item, five-point Likert-type scale and nominal scale which addressed how much is understood about tsunamis by scientists, knowledge of tsunamis by the government and personal experience. Each of the items was bounded by either understood/not understood, known/not known or yes/no scales. Reliabilities for these measures using Cronbach's coefficient for raw and standardized alpha levels were (α = .63 and .67, respectively). Exposure to risk was assessed by utilizing a four-item, five-point, four-point Likert-type scale and nominal scales which address mortality and morbidity and personal vulnerability issues. Each of the items was bounded by a few/don't know, yes/no and frequently/don't know scales. Reliabilities for these measures using Cronbach's coefficient for raw and standardized alpha levels were (α = .58 and .52, respectively). Control over risk was determined by utilizing a six-item, five-point Likert-type scale and nominal scale which addressed morbidity and mortality, personal vulnerability, protection and evacuation issues. Each of the items was bounded by strongly can control/cannot control, agree/strongly disagree and yes/no scales. Reliabilities for these measures using Cronbach's coefficient for raw and standardized alpha levels were (α = .64 and .62, respectively). Dread of risk was determined by utilizing a two-item, five-point Likert-type scale which addressed personal vulnerability issues. Each of the items was bounded by a great deal/don't know and frequently/don't know scales. Reliabilities for these measures using Cronbach's coefficient for raw and standardized alpha levels were (α = .60 and .60, respectively). Risk to future generations was assessed using a two-item, five-point Likert-type scale that addressed safety and cost issues. Each of the items was bounded by strongly agree/strongly disagree. Reliabilities for these measures using Cronbach's coefficient for raw and standardized alpha levels were (α = .89 and .89, respectively). Catastrophic potential was assessed using a two-item, five-point and six-point Likert-type scale that addressed frequency of tsunamis in Hawaii and damage issues. Each of the items was bounded by frequently/don't know and a lot of damage/don't know scales. Reliabilities for these measures using Cronbach's coefficient for raw and standardized alpha levels were (α = .53 and .56, respectively). Global catastrophe was assessed using a one-item, five-point Likert-type scale that addressed frequency of tsunami occurrence around the world. Each of the items was bounded by a frequently/don't know scale. Reliabilities for these measures using Cronbach's coefficient for raw and standardized alpha levels were (α = .89 and .89, respectively). Changes in risk was assessed using a two-item, five-point scale Likert-type scale that addressed tsunami frequency in Hawaii. Each of the items was bounded by very likely/don't know scales. Reliabilities for these measures using Cronbach's coefficient for raw and standardized alpha levels were (α = .83 and .83, respectively). Immediacy of risk was assessed using a three-item, three-point Likert-type scale that addressed location and personal vulnerability issues. Each of the items was bounded by yes/don't know. Reliabilities for these measures using Cronbach's coefficient for raw and standardized alpha levels were (α = .62 and .65, respectively). Religiosity/Spirituality was assessed using a one-item, three-point Likert-type scale that addressed the religious and/or spirituality of the survey participant. The item was bounded by yes/sometimes. Communication Channels were ranked according to the data gathering and protective adaptive behavior activities which the survey participants would take in the event of a theoretical and actual tsunami. This variable consisted of six questions which contained either seven or nine activities. The participants prioritized their responses by ranking their activities as first, second and third. Tsunami knowledge was assessed by nine questions which consisted of multiple choice answers and/or bounded by a three-point scale and queried the survey respondents' sources of tsunami information comprehension of nomenclature. Five of the questions utilized a scale was bounded by yes/don't now.

Various sociodemographic characteristics of the sample (i.e., gender, age, marital status, presence or absence of dependent children, elderly people in respondent household, language spoken at home, education attainment, length and location of residency in Hawaii, religious affiliation and race - ethnicity) were measured in the survey questionnaire. The categories chosen for the sociodemographic characteristics of the survey were taken from the National Crime Survey (Skogan, 1990).

The Raw and Standardized scores were relatively stable for each of the inter-item risk perception measures. While it is perhaps more acceptable to have the Cronbach Coefficient Alpha correlations of $\alpha = 0.65$ or greater, some of the values noted for this survey fall just below this "gold standard" and will be considered satisfactory for the internal consistency and reliability of the instrument (Abramson, 1994; Cronbach, 1947, 1951).

The second questionnaire measured two risk characteristics (i.e., known versus unknown and worry versus non worry) in relation to 27 natural and technological hazards. The natural hazards consisted of floods, hurricanes, asteroids hitting the Earth, tsunamis, landslides, earthquakes, flash floods and volcanoes. The technological hazards consisted of cigarette smoking, pesticide in food, acquired immune deficiency syndrome (AIDS), drinking alcohol, motor vehicle accidents, video display terminals, tap water, nuclear accidents, satellites falling to the Earth from its orbit, medical x-rays, crime and violence, prescription drugs, global warming, street drugs, bacteria in food, ozone reduction in the atmosphere, high voltage power lines, commercial air travel and nuclear waste. The risks were measured with a five-point Likert Scale (i.e., nothing, a little, some, a lot and not sure). Only the data for the variables which measured know a lot with worry a lot are included in the dissertation. The ordinal data obtained from this questionnaire was graphically displayed on a two-factor space scatterplot. Various sociodemographic characteristics of the sample in relation to the risk perception of the 27 natural or technological hazards were also explored in the survey questionnaire.

Data collection. A random sample of adults were selected from the jury pool of the First Circuit Court in Honolulu, Hawaii. The survey was administered on eight separate days from February 10 to 21, 1995. From this initial pool of 445 jurors, 357 completed the entire survey, 75 completed part of the survey, and 13 refused to participate, resulting in an 80.2% response rate (see Appendix A, Table A12). The 357 completed questionnaires were used in this survey. Those questionnaires which were insufficiently completed consisted of some pages which were overlooked or forgotten. This effect was primarily noted for the last page of the questionnaire which may either indicate it was not completed due to boredom or insufficient time for those survey respondents with reading difficulty to adequately complete the questionnaire. The most common reasons for non-completion of the questionnaire were either insufficient time (16.9%) or an ESL difficulty in understanding the questionnaire (2.9%). It is difficult to determine just how many of the questionnaires were not completed because of a respondent's "hostility" toward anything which was not part of the jury selection process. While a lost case analysis may prove useful in determining if the findings of this research would have been skewed if the cases were included in the research database, it should be noted that the majority of questionnaires which were not completed were the result of only one sampling date which had insufficient time to complete the questionnaire (see Appendix A, Table A12). The remaining 2.9% of the respondents who were not included in the research database did not adequately complete or forgot to complete parts of the questionnaire or had an English as a second language (ESL) difficulty. However, Judd et. al., 1991, states that "... a low response rate calls into question any conclusions based on the data. A response rate of 80-90%, on the other hand, means that even if the nonrespondents differ substantially from those who respond, the overall estimates will not be badly biased" (p. 216).

<u>Data preparation and processing.</u> A "code book" was developed to delineate how the data was to be coded and subsequently inputted into the University of Hawaii mainframe IBM 3270 computer. The single data entry was performed by the University of Hawaii computing center. While it would have been optimal to have the University of

Hawaii Computing Center duplicate the input of the data on two different days, both time and cost considerations prohibited this procedure. To determine the quality control of the data input by the Computing Center a manual count of the data for every 10th research variable was performed by the author. The results of this quality assurance confirmed that the data entry by the computing center was consistent for the variables which were rechecked manually by the author. (The statistical tests were performed using the statistical analysis program SAS, (version 6.08) at the University of Hawaii.)

Statistical methodology. The ordinal data collected from the questionnaire was analyzed with standard univariate statistics (e.g., medians, means, skewness, frequency distribution, etc.). The statistics utilized to measure the association for ordinal variables by cross-classification are Chi-Squared Goodness-of-Fit and Cramer's V. Cramer's V allows analyses of tables greater than 2 x 2 and determines the strength of the association given a statistically significant Chi-Square. Correlations were analyzed with Pearson Correlation Coefficients r and r^2. The r^2 determines the strength of the correlation as to whether it is strong, moderate or weak. (Abelson, 1995; Agresti & Finlay, 1986; Freund & Littell, 1991; Hildebrand, 1986; Miller, 1991; Walsh, 1990). Although the Pearson product-moment r and r^2 primarily measures interval-level data, this study treated Likert scale ordinal-level categories as interval-level data. Labovitz (1970) addressed the question as to whether or not to treat ordinal-level variables as interval-level variables in order to take advantage of more advanced statistical analyses. He concluded that the decision to treat ordinal-level variables as interval-level variables depends on the researchers' statistical philosophy and that "... the assignment of a linear scoring system to 'partial interval' data results in negligible error and the advantages of doing so far outweigh the disadvantages" (p. 520). Scatterplots were conducted on the data obtained from the two-factor space instrument (Hildebrand, 1986). Statistically significant Chi-Square and Pearson product-moment (r and r^2) results are based on a significance level of

$\alpha = .05$. The criterion for achieving statistical significance was determined by conventional statistical usage; however, many nonstatistically significant findings may be valuable for understanding risk perception. However, convention states that nonstatistically significant findings may be due to chance alone; therefore, only conventional standards of significance will be reported in this dissertation.

Sociodemographic variables. The Chi-Squared Goodness-of-Fit analysis of the data obtained from the questionnaire demonstrated that many of the Likert Scales used to measure risk perception of tsunamis produced contingency tables with cells of less than five which resulted in unstable Chi-square statistics. Therefore, the Likert Scales used to measure demographic variables were collapsed in order to circumvent this situation.

Collapsing many of the sociodemographic variables resulted in an increase in contingency tables with cells of greater than five which resulted in stable Chi-square statistics. For example, the original classification for race-ethnicity consisted of 13 categories such as Black, Chinese, Filipino, Hawaiian, Portuguese, Part-Hawaiian, Japanese, Korean, Puerto Rican, Samoan, Mixed, White and Other. Statistical analyses of this data, in relation to tsunami risk perception, indicated that because "n" percentage of the cells have expected counts of less than 5 the Chi Square may not be a valid test. Consequently, much of the data which comprised the 13 categories were not able to meet the minimum cell, or marginal requirements, in order to perform the Chi Square test. However, when the 13 race-ethnicity categories were collapsed into 4 categories (i.e., Other, Asian, Pacific Islanders and Whites) there were 6 questions which exhibited statistical significance, although some cells still contained cell and marginal counts of less than 5 which disqualifies analysis by the Chi Square statistic. An additional example of the effects of collapsing the variables to achieve adequate cell and marginal counts can be observed for income categories in relation to tsunami risk perception.

The original classification for income ($) consisted of 7 categories (i.e., < 15,000, 15,000 to 24,000, 25,000 to 34,000, 40,000 to 49,000, 50,000 to 74,000, 75,000 to 99,000 and > 100,000) of which no statistically significant values were obtained. However, when the categories were collapsed into 3 categories (i.e., <25,000, 25,000 to 74,000, 75,000 to >100,000) there were 4 questions which were then statistically significant, although some cells still contained an expected count of less than 5. Therefore, collapsing the various Likert scale measures of the sociodemographic variables resulted in stable Chi-Squared Goodness-of-Fit contingency tables when compared to the non-collapsed variables.

The demographic variable of age of the survey participant was collapsed into 3 categories: young adult (19-35 years of age), middle adult (36-50) and older adult (51-75) (see Appendix A, Table A5 for a delineation of respondent ages for this survey). The scales which measure the respondents' marital status were collapsed to simply measure whether the participant is single or married compared to the original Likert scale which measured various classification of marital status (i.e., divorced, widowed, separated and other) (see Appendix A, Table A6). The demographic questions which confirm and/or quantify the presence or absence of dependent children or elderly in the participants' household were collapsed to either no or yes as to the status of these dependents (i.e., the category of "sometimes" was categorized according to how many children or elderly resided in the home of the survey respondent) (see Appendix F for a breakdown of how many children or elderly reside in the respondents' household).

The demographic analysis of the educational attainment of the survey participant was also collapsed from 9 to 4 categories which are comprised of 0-12 grade (no school, 6th grade or less, 7th grade to 8th grade and 9th grade to 12th grade), community or technical college, some college and college degree (undergraduate, advanced degree). Likewise, the demographic question which measures total family income was collapsed from an original 7 to 3 categories; i.e., less than $25,000 (< $15,000 and $15,000 to

$24,999), $25,000 to $74,999 ($25,000 to $34,999, $35,000 to $49,999 and $50,000 to $74,999) and $75,000 to $100,000 and more ($75,000 to $99,999 and $100,000 or more).

The demographic measurement of the length of residency of the survey participant was collapsed from an original 5 categories to only 2 categories; i.e., residency of less than 18 years (< 3 years, 3 to 5 years, 6 to 9 years and 10 to 17 years) and of 18 years and more. Six geographic Civil Defense districts were used to indicate where the survey participants resided. The Civil Defense (CD) districts were chosen because of previous research which indicated the quantity of people who are at-risk from tsunamis according to CD district (Curtis, 1991). Civil Defense districts were not collapsed or aggregated and consisted of District 1 (Honolulu area), District 2 (Waialua area), District 3 (Maile area), District 4 (Kailua area), District 5 (Kahuku area) and District 6 (Pearl City area) (see Appendix B, Figure B1; Appendix G).

The religious preference of the survey respondents was collapsed from an original 12 to 4 categories; i.e., Other (Atheist, Hindu, Mormon, Muslim, Shintoist and "Other"), Buddhist, Roman Catholic and Protestant (Christian and other Protestant denominations which were indicated on the survey instrument). There were no self-identified Jewish, Shintoist or Hindu survey respondents; however, that does not preclude that these respondents were not part of this survey. Similarly, the demographic measurement of the self identification of the survey participants race-ethnicity was collapsed from an original 13 to 4 categories; i.e., Other (Black, Mix other than Part Hawaiian and "Other"), Asian (Chinese, Filipino, Japanese and Korean), Pacific Islanders (Hawaiian, Part Hawaiian and Samoan) and Caucasians (White, Portuguese and Puerto Rican) (see Appendix A, Table A11 & Appendix B, Figure B16 to compare these collapsed variables with their original non-collapsed categorization).

Review of tsunami related newspaper articles. A summative analysis of 663 tsunami-related articles published in the Honolulu Advertiser and Star Bulletin (1929-

1994) was coded according to six categories; "specific tsunami information" (of actual tsunamis), "general tsunami information" (educational), "human interest stories", "tsunami warnings and tsunami warning systems", "legislative activities" and "tsunami statistics" (mortality, morbidity and monetary loss).

Those newspaper articles which are concerned with specific tsunami information covers the actual tsunami event from its generation to its effect on the Hawaiian Islands. The newspaper articles which are coded as general tsunami information informs the public about the general characteristics of tsunamis. These articles are often "piggy-backed" with the specific tsunami articles as a means of explaining the frequency, risk potential and mechanics of tsunamis. Those newspaper articles coded as human interest stories are concerned with actual experiences people may have had with the "present" tsunami or remembrances of past tsunami experiences. Very often human interest stories will appear in the newspapers to coincide with the anniversary of a previously destructive tsunami. Newspaper articles which are concerned with the actual tsunami warning or with advances in the tsunami warning system comprise the second largest category of tsunami-related articles. The articles usually relate the adequacy or inadequacy of the tsunami warning system; i.e., sirens, media coverage and communication processes. Newspaper articles which deal with the legislative aspects of pre or post tsunami impact usually are concerned with land-use patterns or in fiscal appropriations concerning tsunami mitigation. The last category of newspaper articles which was explored for this dissertation concerned the statistics primarily concerned with loss of life and/or property resulting from a destructive tsunami.

All tsunami-related newspaper articles for the tsunamis which occurred in 1946, 1960, 1975, 1986 and 1994 were analyzed to determine the multicategory system of risk perception in relation to tsunamis; e.g., delineation of indicator words or phrases which pertain to risk perception concepts such as voluntariness of risk, ease of reduction of risk, newness of the risk, knowledge about risk, exposure to risk, control over risk, dread of risk, risk to future generations, catastrophic potential, global catastrophe, changes in risk, immediacy of risk and religiosity/spirituality. Coding of the newspaper articles was exclusively performed by the author because of time and expense considerations. (Note: The newspaper analysis conducted for this dissertation is not a "traditional" content analysis and serves only to illustrate the various risk perception categories which are covered during a selected group of major and minor tsunamis.)

CHAPTER 4

RESULTS

This chapter will present the results of how survey respondents comprehend tsunami nomenclature. The generating sources and location of tsunamis, various definitional inquiries as to tsunami nomenclature, as well as the sources of tsunami education/knowledge was explored. This section is then followed by reviewing tsunami-related newspaper articles obtained from the Honolulu Star-Bulletin, Honolulu Advertiser, Sunday Star-Bulletin and the Hilo Tribune-Herald from 1929 to 1994 to determine the influence of the media relating risk perception characteristics. Specific tsunamis that occurred in 1946, 1960, 1964, 1975, 1986 and 1994 were analyzed according to the risk perception characteristics of voluntariness of risk, ease of reduction of risk, newness of the risk, knowledge about risk, exposure to risk, control over risk, risk to future generations, catastrophic potential, global catastrophe, changes in risk, dread of risk, immediacy of risk and with the religiosity and or spirituality of the survey respondent.

The sociodemographic characteristics of the Jury Pool of The First Circuit Court in Honolulu was obtained from the 357 completed questionnaires used in this survey. The demographic characteristics of the jury pool were categorized and analyzed according to gender, age, language spoken at home, marital status, presence or absence of children or elderly, educational attainment, total family income, length of residency, geographic distribution, religious preference, race and or ethnic identification.

This segment is then followed by a statistical analysis of the risk perception characteristics expressed by the survey respondents in relation to tsunamis. Specific questions such as; (1) whether or not the risks from tsunamis are voluntarily undertaken (voluntariness of risk); (2) can the risks from tsunamis be easily reduced (ease of reduction); (3) how familiar are survey respondents with tsunamis (newness of risk); (4)

how much is known by the government and science concerning the risks of tsunamis (knowledge about risk); (5) do survey respondents understand what will happen to them should they be exposed to a tsunami (exposure to risk); (6) do survey participants feel that they can control what happens to them should they be impacted by a tsunami (control over risk); (7) what is the comprehension of the survey participants as to the catastrophic potential of tsunamis (global and local catastrophic potential of risk; risk to future generations); (8) how often do the respondents feel tsunamis will be occur in Hawaii and the world (changes in risk); (9) do the participants worry about tsunamis when they are near the vicinity of the sea shore (i.e., work, residence, swimming, boating, surfing, fishing) (dread of risk; immediacy of risk); and finally, (10) does the religiosity or spirituality of the individual influence their risk perception of tsunamis (religiosity/spirituality), were explored in this research.

Following this section, an exploration of the various communication channels that people employ to secure tsunami-related information was analyzed for a theoretical tsunami and for the October 4, 1994 mini-tsunami. Information gathering, evacuation procedure and communication channels were explored in relation to three time intervals before tsunami impact (now, five hours, and ten minutes).

Finally, a cognitive map was constructed for 27 natural and/or technological hazards. The data was ranked and classified according to type of hazard and how much people know (a lot) and worry (a lot) about these hazards.

Comprehension of Tsunami Nomenclature

The layperson's comprehension of the "specialty language" which surrounds the science of tsunamiology, as well as the extent of this knowledge and its effect on tsunami risk perception was explored in this section.

Tsunami knowledge. Survey respondents were queried as to the meaning of the word "tsunami". Survey respondents identified tsunamis by its previously popular term of tidal waves (42.9%), followed by seismic sea waves (26.1%), a combination of seismic sea waves and tidal waves (21.8%), or as seismic sea waves, harbor waves and tidal waves (4.8%) and exclusively as harbor waves (0.3%) (see Appendix A, Table A14). Additionally, 2.4% of the respondents incorrectly assumed that air currents can cause tsunamis and/or linked this erroneous source with correct tsunami nomenclature such as tidal wave, harbor wave and seismic sea waves. Fortunately, only 1.7% of the respondents did not know what the word tsunami meant.

The participants were questioned as to the various geophysical generating forces which produce tsunamis. The survey respondents linked the causation of tsunamis predominately with earthquakes (59.7%), followed by combinations of earthquakes with volcanoes (9.5%), landslides (no delineation between subaerial and submarine) (9.5%) or with both landslides and volcanoes (9.5%) (see Appendix A, Table A15). Only 3.1% of the respondents exclusively chose landslides as the causative power which produces tsunamis. Interestingly, 2.2% of the respondents chose winds as the sole causative mechanism producing tsunamis or in combination with earthquakes and volcanoes, landslides (3.0%). Volcanoes were indicated by 1.4% of the survey respondents to be the primary cause of tsunamis. Only 2.0% of the respondents did not know the causative mechanism of tsunami generation.

The survey respondents were queried as to the location of tsunami evacuation zones (i.e., mountains, beach/shore, stream banks, or far away from beach or shore). Approximately 56.6% of the survey respondents incorrectly identified the location of "evacuation zones" as "far away from the beach or shore" (48.7%) and/or in the "mountains" (7.9%); however, 40.9% of the respondents correctly identified evacuation zones as "at the beach or shore" (see Appendix F). If the respondent was not able to correctly define an evacuation zone then those questions contingent upon a correct answer (6, 8, 14, 15 and 17) could not be analyzed with the responses given by the other 40.9% of respondents who were able to correctly define the term evacuation zone.

When the survey participants were asked if they understand how the tsunami warning system works, they overwhelmingly responded positively (84.3%), while only 5.1% responded negatively. Interestingly, 10.7% of the respondents were not sure as to whether they understood the tsunami warning system or not (see Appendix F). However, the veracity of this question is subject to conjecture since, unfortunately, no criterion check was incorporated into the questionnaire to determine if indeed their understanding of the tsunami warning system was correct or incorrect.

The participants were questioned as to whether or not they understand what the words inundation and run-up means. Approximately 55.3% of the participants stated that they understood what the word inundation meant, while 39.4% responded that they did not understand, while 7.0% were not sure what it meant (see Appendix F). The word inundation in comparison with run-up elicited more confidence on the part of respondents as to its meaning. Only 25.8% of the survey participants reported that they understood what the word run-up meant, while 63.8% stated that they did not and 10.4% were not sure. The veracity of this question is again subject to conjecture since no criterion check was incorporated into the questionnaire to determine if their understanding of the words inundation or run-up was correct or incorrect. It is interesting to note however, that the survey participants did not summarily answer in the affirmative when they did not know what the word or term meant.

The participants were queried as to whether or not they understand the difference between a tsunami which occurs near to the Hawaiian Islands with those which come from far away countries. Whether or not the survey participants "understand the difference between a tsunami which is produced near the Hawaiian Islands and those that come from far away countries" is open to conjecture because no criterion check was incorporated into the survey instrument. An argument for veracity, without a confirmational criterion check, may also be applied to this question, since 46.5% of the respondents stated that they did understand the difference versus 22.1% responding that they did not understand the difference, while a sizable 30.5% stated that they were not sure (see Appendix F). Curiously, 0.8% stated that they don't care which perhaps can be correlated with the participants perception of the frequency of tsunamis in Hawaii. Clarification of these questions awaits further research.

Therefore, while it would be interesting to take the information concerning survey respondent comprehension of the tsunami warning system, tsunami nomenclature of inundation and run-up, and the difference between tsunamis which occur proximal or distal to Hawaiian Islands , these data must be interpreted with caution since no criterion checks were incorporated into the survey instrument. Therefore, arguments as to the veracity of their comprehension concerning these questions should be considered but not unequivocally accepted without appropriate criterion verification.

The survey respondents were queried as to their source(s) of tsunami information or knowledge. The predominant source was obtained from television and radio (52.8%), followed by school (12.6%), previous personal experience (8.7%) and a combination of television or radio with school education (7.9%) (see Appendix A, Table A41). Interestingly, only 3.9% of the respondents obtained their tsunami knowledge exclusively from friends and relatives. However, 14.9% of the survey participants indicated that their tsunami information or knowledge was acquired through a combination of school with friends and relatives (0.3%), television and radio (7.9%), television or radio and friends or relatives (2.8%), personal experience (1.1%) and other combinations of sources.

When the survey participants were asked if the quantity of tsunami information offered by Civil Defense via television and radio was sufficient, 67.6% indicated affirmatively, while 20.3% did not feel this information was adequate, and 12.1%

responded that they don't know. When the respondents were queried about the quantity of tsunami education taught in the school system, only 24.1% replied that the quantity was sufficient, while 37.3% indicated that this information was insufficient. The remaining 38.7% of respondents indicated that they don't know (see Appendix F).

Media Influence on Survey Respondents' Risk Perception of Tsunamis

Information such as how many articles are concerned with general tsunami information (theoretical tsunami, educational), specific tsunami information (actual tsunami), human interest stories, the tsunami warning system, legislative concerns and statistics (morbidity, mortality, monetary concerns) would be helpful to determine the number and kinds of articles covered by the newspapers. Additionally, an analysis of newspaper articles which covered the tsunamis of 1946, 1952, 1957, 1960, 1964, 1975, 1986 and 1994 can help determine which risk perception categories were presented to the public (i.e., voluntariness of risk, immediacy of risk, tsunami knowledge by science and/or government, religiosity/spirituality, risk to future generations, cost to future generations, changes in risk, familiarity of the risk, dread of the risk and catastrophic potential). Therefore, determining what information the media disseminates concerning the risk perception of tsunamis could help in formulating agenda-setting strategies by the public health and Civil Defense communities.

Review of Tsunami-Related Newspaper Articles

From 1929 to 1994, 633 tsunami-related articles were printed in the Honolulu Advertiser and Star-Bulletin; 207 general tsunami information articles (31.2%), 96 specific tsunami information articles (14.5%), 88 human interest stories (13.3%), 162 tsunami warning and systems articles (24.4%), 32 legislative articles (4.8%) and 78 statistical (11.8%) articles (see Appendix A, Table A40). Tsunami-related newspaper articles were rather sparse for the years 1929 to 1945; however, after the highly destructive tsunami of 1946 the number of newspaper articles has increased substantially (see Appendix B, Figure B9). A trend in the quantity of tsunami-related newspaper articles can be noted with an increase followed generally by an exponential decrease in tsunami-related newspaper articles after either a major or minor consequence tsunami. The tsunamis of 1946, 1952, 1957, 1960, 1964 and 1975 generated the most tsunami-related articles because of their impact on life or property; however, the mini-tsunamis of 1986 and 1994 also generated a number of tsunami-related newspaper articles. This observation could be related to the infrequency of destructive tsunamis in Hawaii and the economic impact of a natural hazard of minimal consequence. A "local discussion" in the Honolulu Star-Bulletin and the Honolulu Advertiser through the editorial or op-ed pages (i.e., opposite the editorial) indicated that public wanted improvements made in the tsunami warning system following the disastrous 1946 tsunami.

The Hawaii newspapers contained very few tsunami related articles from 1929 to April 1, 1946. These articles were primarily involved with canceling tsunami warnings, or as noted in 1932, with a history of "tidal waves" which had impacted the Kingdom or Territory Hawaii. The public reaction to the actual or potential tsunamis was not noted in any of the 7 articles which appeared from 1929 to 1946. Following the March 6, 1929 earthquake centered in the Aleutian Islands, the residents of the Island of Kauai were in a "near panic" to evacuate. The same article discusses the occurrence and history of tsunamis around the world. On November 10, 1938 another earthquake centered in the Aleutians Islands generated a mini-tsunami of "baby waves", and in an article dated November 11, 1938, the residents of Hawaii stated that they felt they had "little to fear" from this earthquake and resultant tidal wave. No effective tsunami warning system existed at this time other than the placing of banners near the ocean when news of a potentially tsunamigenic earthquake had been generated.

The tsunami of April 1, 1946. A submarine earthquake off the Aleutian Islands between 2 and 5 a.m. on Monday April 1, 1946 produced the most destructive tsunami to strike the Hawaiian Islands in modern history. Residents had no warning that the Alaskan earthquake had generated a powerful tsunami. Ironically the first bits of information the residents had received via the “coconut wireless” concerning the possibility of a tsunami approaching the Hawaiian Islands was misconstrued for an April Fool’s Day practical joke. Indeed, when William Gabrielson (Chief of Police for the City and County of Honolulu) had first heard the news of the approaching tidal waves, he thought that the information was nothing more than a hoax.

The 1946 tsunami produced the largest number of tsunami related newspaper articles ever seen before in the Hawaiian Islands. The majority were concerned with the vital statistics of those residents who were dead, injured or missing. The people of Hawaii were understandably distraught that they had received absolutely no warning of this impending disaster.

Lt. Commander William Patterson, Supervisor of the Pacific District of the U. S. Coast and Geodetic Survey, was quoted as saying, “I know of no manner by which anyone here - or on the mainland - could have told that a tidal wave was going to hit Hawaii” (Honolulu Advertiser, April 2, 1946). Lt. Cdr. Patterson also stated “... that while human ingenuity has devised a warning system against every other kind of natural disaster, it has yet to develop a means of gathering advance information against tidal waves” (Honolulu Star-Bulletin, April 2, 1946). A particularly poignant article headlined “Failure to Warn T. H. (Territory of Hawaii) Faces Probe” was run by the Associated Press. The report stated that a seismic disturbances had been recorded 5 hours before the tidal wave reached Hawaii, but that the Coast and Geodetic Survey had given no tsunami warning (Honolulu Star-Bulletin, April 2, 1946). An editorial in the Honolulu Star-Bulletin stated: “... The lack of a tsunami warning here was due not to the fact that no equipment exists which can forecast tidal waves - for such equipment does exist - but to the fact that the equipment was not here and operating” (April 3, 1946).

Various human interest stories concerning risk perception categories such as voluntariness of risk, immediacy of risk, and tsunami knowledge were noted in many of the newspaper articles. For example, in an article which appeared in the Star Bulletin on April 2, 1946 entitled "Waikiki Blues May be Sung by Beach Boy" a housewife peering out at the beach from a passing bus in Waikiki said "I told that son of mine to stay away from the beach today. If he dared disobey me ..." (Honolulu Star-Bulletin, April 2, 1946). In another article entitled "Sea Acted Strangely before Tidal Wave," Stowell Wright of Lanikai noted, "... I went to the beach at about 6:35 a.m. after I heard reports that the ocean was acting in a strange manner" (Honolulu Advertiser, April 2, 1946). Perhaps one of the most bizarre articles headlined "Ship Picks up Hilo Survivors; Atomic Bomb Rumors Pop Up" reads: "One of the first calls received by The (Honolulu) Advertiser on the tidal wave was from an unidentified woman. She wanted to know if the army had accidentally dropped one of the atomic bombs (which had produced the tidal wave)" (Honolulu Advertiser, April 2, 1946).

Hawaiian legends such as "Pele Keeps Promise by Paying Visit Before Tidal Disaster" which appeared in the Honolulu Star-Bulletin on April 3, 1946, demonstrated the religiosity or spirituality of Pacific Islanders. The article discussed a story concerning the visitation of Madam Pele to the "Garden Island" of Kauai. Madame Pele usually appears preceding a volcanic eruption either as a young woman or as an old woman carrying firewood. The story relates that:

> The Volcano Goddess has put in an appearance well in advance of most seismic outbreaks in Hawaii, and yesterdays tidal wave was no exception.
>
> Kamaainas on the Garden Island pointed to an incident last December involving, Gilacio Pascual, truck driver of

> Kapaa, Kauai, to bolster their claim that Madam Pele always - or nearly always - pays an advance visit.
>
> Apparently, Mr. Pascual had picked up a schoolgirl hitch-hiker near Koolau Store who wanted to be dropped off at Moloaa baseball park. She had informed him that she knew him but would not tell him her name, "The next time I see you, I'll tell you" she said. As Mr. Pascual's truck was approaching a hairpin turn in the road he stuck his head out the window to help him navigate and when he had finished he noticed that the girl was gone and the door was still tightly shut.
>
> Most of the people who had believed Pascual had chauffeured the Volcano Goddess thought her appearance indicated an eruption was coming on the Big Island. But they did not imagine that Kauai would be directly affected by one of Pele's outbursts.

Another fascinating Hawaiian Legend concerned with Pacific Islanders' religiosity or spirituality of impending disaster was reported in a Letter to the Editor by Mr. Frank Kaihunui in the Honolulu Advertiser on April 4, 1946. The headline for this article was entitled "Boki Gave Tidal Wave Warning"

> Letter to the Editor: Early Sunday evening, after returning from a family visit, I noticed my wife going out onto the front porch twice to investigate something. On her second attempt, I became inquisitive and asked her what she was doing. She replied that she was going out to satisfy herself of what she had seen earlier.

When she returned she told me she had seen Boki. Now in Hawaiian legend, Boki was one of the gods which took the form of a dog. It is related that wherever and whenever it is seen, it is a sign of a "warning." That night, the wife saw Boki in the form of a huge black dog, leaving the front yard and disappearing as soon as it reached the road.

"I'm afraid something disastrous is going to happen," said the wife, "and if it does, I hope none of the family will be in it." The next morning the news of the tidal wave was released.

A Hilo barmaid who worked at the Naniloa Hotel describes her personal experience with the April 1, 1946 tsunami. An article headlined as "Hilo Barmaid Recovering from Narrow Escape; Badly Bruised" appeared in the Honolulu Advertiser, April 4, 1946:

> I heard a neighbor calling me, and he seemed very excited. I went out into the yard and saw the wave coming. I had seen tidal waves before and I didn't think anything about it. I went back into the house after the first wave washed around my feet and when I came out the second wave took me and the house with it.

The risk and costs of tsunamis to future generations was covered in an editorial which appeared in the Honolulu Star-Bulletin on April 3, 1946. The article discussed the damage done to the city of Hilo and the need for a better tsunami warning system:

> ...but we can add substantially to protection of the future. One million of the millions of dollars damage wrought in a few minutes last Monday morning will give the people of Hawaii an adequate tsunami warning system and keep it manned

> indefinitely. Skeptics and casual scoffers will say "it never happened before - it won't happen again - why spend the money."

Newspaper articles which were concerned with the urban renewal of the city and waterfront of Hilo and the cost to future generations appeared in the Honolulu Star-Bulletin on April 6, 1946 (5 days post tsunami): "Waterfront Esplanade May be Hilo's Postwave Project" and "New and Greater Hilo Expected to Rise from the Wave Wreckage" and "Some Benefits May Come from Monday's Disaster". The latter article quotes George Houghtailing of the Honolulu City Planning Commission: "...made recommendations to the Hilo Planning Commission that reconstruction of business buildings on the waterfront be prohibited." This sentiment was echoed by Dr. Jaggar (Volcanologist) who noted in the same newspaper edition that "... more and more should be done for the safety of the public and for the protection of the beauty of our shore". Interestingly, Lorrin Thurston reported that "... Land in and around Hilo is plentiful, but owners who are willing to sell are hard to find, hence government action will probably be necessary if the City of Hilo is going to develop and grow on intelligent, modern lines" (Honolulu Advertiser, April 8, 1946).

On April 23, 1946 another headline, "Hilo Waterfront Plan Discussed", in the Honolulu Advertiser quoted Representative Joseph Andrews:

> The idea of a park was fine, but the dreamers could not possibly tell him where the money would come from. This county has been broke ever since it was born. We talk about buying the land now occupied by merchants. the Hilo Theater alone will cost $200,000 and I'll eat my hat if American Factors ask less than $250,000 for their land along the ocean ...

> the Bishop Estate and other trusts will get the long end of any exchanges.

However, the greatest number of articles to appear as a result of the April 1, 1946 tsunami were concerned with the vital statistics of those who were killed, injured or presumed missing as a result of this natural disaster.

The most heartbreaking newspaper articles concerned the teachers and students who were killed, injured or lost when their school house in Laupahoehoe was destroyed in the early morning tsunami. Perhaps, no other article sums up whether an individual can control what will happen to them if struck by a tsunami. Shop teacher, Mr. Frank Kanzaki remarked in the Honolulu Star-Bulletin on April 4, 1946 that "... fifteen minutes later the students would have been in their classes in the school building which was only slightly damaged, instead of on the beaches and grounds waiting for classes to begin".

The key words "risk perception" was not mentioned in any of the 1946 newspaper articles. Human interest stories relating individual heroism in the face of this natural disaster were numerous, as were chronologies of vital statistics; however, risk perception articles were negligible or circuitous, if not totally absent.

The tsunamis of November 5, 1952 and March 11, 1957. Prior to the May 23, 1960 tsunami, two small tsunamis hit the Hawaiian Islands on November 5, 1952 and on March 11, 1957 and caused minor damage. However, a large number of false alarms since the 1957 tsunami caused many frustrated residents to refuse to evacuate for a tsunami alert on May 4, 1959. Civil Defense had changed the tsunami siren warning system in November of 1958 from a multiple siren warning to a single siren blast which was the only signal that residents should evacuate tsunami inundation zones immediately.

The tsunami of May 23, 1960. On Saturday May 22, 1960 a submarine earthquake off the coast of Chile generated a tsunami which produced Pacific-wide devastation. The tsunami waves took approximately 15 hours to cross the Pacific Ocean and arrived in

Hilo, Hawaii on Sunday May 23, 1960 at 12:10 a.m. The tsunami resulted in 61 casualties and numerous injuries in Hawaii; most of the casualties occurring in Hawaii were in the city of Hilo. The State of Hawaii had been warned of the approaching tsunamis approximately 13 hours in advance. Civil Defense tsunami sirens were sounded at 8:30 p.m. consisting of one blast of one minute duration followed by 3 minutes of silence. This routine was repeated five times in succession. No further tsunami siren blasts were to occur for the rest of the warning period.

Risk perception concepts such as changes in risk and catastrophic potential of an actual tsunami hitting the Hawaiian Islands was expressed by some residents as "...well it isn't likely to happen." The Hilo Tribune-Herald on May, 24, 1960 observed that people made "...no move to leave the area as if spellbound by the awesome sight. They wouldn't have had a chance." An editorial in the Honolulu Advertiser on May 24, 1960 noted that a "Civil Air Patrol (CAP) airplane spotted people walking on the narrow strip of sand below Diamond Head lighthouse. Had a wave come at that moment, their walk would have been a suicide stroll." Another incident noted by Army Public Information Specialist, Jim Price on Banyan Drive, Hilo, Hawaii said "... Our view was somewhat obscured by the many people rushing to the sea to attempt to catch the fish grounded by the wave" (Hilo Tribune-Herald, May 25, 1960). In an article appearing in the Maui News on May 25, 1960 reporting on the tsunami which struck Hilo, the following was printed: "... many of those awake were asleep to the impending danger. Their sense of curiosity sent them running to the edge of the sea. Other lost their lives because they felt the screaming sirens signaled another cry of wolf". To be fair, an editorial in the May 29, 1960 Honolulu Star-Bulletin noted:

> ... Many people felt the May 23rd tsunami was just another "false alarm". Many felt that since they went through the 1946 tsunami unharmed then the same pattern would hold now.

> Others felt that since they live on the second floor water would never get that high.

One particularly poignant human interest article concerned the religiosity or spirituality of a woman (Mrs. Fuayo Ito) who survived for 5 1/2 hours at sea by floating on a house screen. When the woman was rescued she said, "I was scared, scared, scared. From then on it was long periods of praying." Mrs. Ito thought her house would be safe and she didn't feel in too much danger. She didn't want to disregard the alert but people were "taking up vantage spots to watch the tidal waves. She felt safe" (Honolulu Star-Bulletin, May 25, 1960).

Police officers on the Island of Hawaii using loudspeakers (penetrators) in relatively remote coastal areas not within hearing distance of siren warnings, broadcasted to residents the warning: "Tidal wave action expected. Move to higher ground (repeat) Move to higher ground. Inform your neighbors" (Honolulu Advertiser May 24, 1960). Unfortunately, many people did not heed that warning. An editorial in the Hilo Tribune-Herald on May 24, 1960 expressed the confusion with hearing or understanding the tsunami warning system. "The tsunami warning system that evolved in the years since the 1946 tidal wave struck without any alert whatever, has deteriorated it seems to us from having too many agencies tinkering with it. The conclusion is inescapable that at least part of the loss of life here was due to malfunctioning of the tsunami warning system." At this time discussion among elected officials and civil defense administrators concerned the Constitutional rights of an individual not to be forcibly evacuated should a tsunami warning be issued. Incidentally, the police did have the authority to force people to evacuate once civil defense siren soundings had been issued and Governor Quinn favored the use of power to force evacuation (Star Bulletin May 24, 1960).

On May 24, 1960, three days after the devastating May 23rd tsunami, another seismic event occurred off the coast of Chile. Scientists had only 2 1/2 hours to determine if the seismic event had indeed generated a tsunami. Time was precious since they had to wait until tidal stations in the Pacific reported abnormal wave activity. Amazingly, the residents of the island of Hawaii were given only 60 seconds to prepare for tsunami impact, while those in Honolulu had only a five minute warning. However, in comparison with the May 23rd tsunami of days earlier, nearly everyone evacuated or headed to higher ground to have good vantage spots in which to view the waves when the call for evacuation was sounded. A newspaper article appearing in the Star Bulletin of May 26, 1960 noted that "... People evacuated Waikiki for a tsunami which never came and watched from roof tops - a lot different than the first evacuation (of a few days previous)." Coincidentally, the May 23rd tsunami had knocked out the tsunami warning system, and tide gauges on the Island of Hawaii were not operational until the day following the tsunami alert (Hilo Tribune-Herald, May 27, 1960).

An editorial in the Hilo Tribune-Herald on May 27, 1960 discussed the urban renewal prospects which the May 23rd tsunami presented to town planners. The <u>cost to future generations</u> was noted: "...The seawall that Hilo had hoped for after the 1946 disaster never materialized. An Army Engineer survey concluded that a wall that would actually protect Hilo would cost more than the value of all the property it would protect." A headline in the Honolulu Advertiser of May 25, 1960 noted "New Hilo on Higher Ground Urged by Master-Planners." An editorial two days later would appear in the Hilo Tribune-Herald of "Tsunami Danger Zone" and that the "... tragic toll in Hilo was the price paid for apathy and complacency. May it never be repeated. ... The Oahu system (tsunami warning system) was set up seven years ago. Since then subdivisions have sprung up in areas where there are no coastal sirens" (Honolulu Star-Bulletin May 27, 1960). An article noted in the Hilo Tribune-Herald on June 11, 1960 headlined "Safety Zone Supported by Observatory Scientist". "The tidal wave alert system is outdated", Dr.

Eaton tells legislators. “Present system adopted 14 years ago is outdated ...the present alert system does not take advantage of the facts known from science itself.”

Dr. Roy Lachman (University of Hawaii at Hilo, Department of Psychology) representing the Big Island Chapter of the Hawaii Academy of Science conducted an extensive postdisaster survey of “the reactions of Hilo victims during the tidal wave”, testified, to the legislators:

> ... I personally can not accept the position that it (the disaster) was the people’s own fault. Each individual was left to interpret for himself what the warning siren meant. The alert to most people in the Hilo area did not mean evacuation. Many Hilo residents were not aware of the changes in the siren warning system adopted by Civil Defense ... the alert to most people did not mean evacuate (Honolulu Star- Bulletin, June 11, 1960).

Ed Engledow (Hilo correspondent for the Honolulu Star-Bulletin) testified that “... many Hilo residents were not aware of the change in the siren tsunami warning system adopted by Civil Defense.” He also stated that he did not question the soundness of the changes but “I do question the lack of education about it” (Honolulu Star- Bulletin, June 11, 1960).

How well science understands the mechanisms of tsunami generation was subject to scrutiny by the media such as in the headline “Erratic Action of Tsunami Waves is Mystery even to Scientists”, as well as “Scientists Can Partly Explain Tidal Wave Action” (Honolulu Star-Bulletin, May 26, 1960 and The Sunday Advertiser, May 29, 1960, respectively).

Protecting future generations from the adverse effects of tsunamis sparked many scientists to come up with innovative ways in which to predict which seismic events would be tsunamigenic. On August 1, 1960, Doak Cox (University of Hawaii, Department of Geophysics) was appointed to direct the tidal wave program at the University of Hawaii. Many ideas to protect the residents of Hawaii were proposed, from copying seawall design from Japan for use in Hilo harbor to the use of hydrophones (via The Pacific Missile Range) to pick up sounds of earthquakes (Hilo Tribune-Herald, August 21, 1960).

On November 14, 1960, a seismic event off the Aleutian Islands triggered a Hawaii Tidal Wave alert. Sirens sounded at 2:50 a.m. The alert was called off at 3:14 a.m. Again, the State of Hawaii was given minimal notice of an impending tsunami because electrical storms north of the state had delayed communications informing the Civil Defense authorities that no tsunami had been generated. Chief Peter Pakele of the Island of Hawaii Civil Defense noted that he was happy with Hilo's reaction, but unhappy about the short lead time of 45 minutes. "We found no one who had come down to see the waves." However, a problem occurred when telephone lines were jammed and the police station couldn't notify disc jockeys that no tsunami had been generated (Honolulu Advertiser, November 14, 1960).

On November 16, 1960, the faculty at the University of Hawaii - Hilo and residents of the Keaukaha subdivision conducted a survey to determine inadequacies in tsunami evacuation procedures. They noted that the evacuation plans for Waiakea Kai School children "... was inadequate in the event they must be evacuated in case of a tsunami. Children have to walk to the airport which is still in the "danger area". What happens in the event of a locally generated tidal wave?" This is the first article which addresses the threat posed by locally generated tsunamis to the safety of the residents of Hawaii (Honolulu Advertiser, November 16, 1960).

An editorial in the Honolulu Star-Bulletin on November 16, 1960 addressed the problem of desensitization by noting that penetrators (loudspeakers) "... should be prohibited from private or public use. During the election campaign people grew so accustomed to the blaring mobile loudspeakers that they stopped paying any attention to them. People will listen if they know that such devises will be used only in case of emergency."

While more risk perception categories were noted in the 1960 tsunami related articles when compared to similar articles noted in 1946, the vast majority of articles dealt with vital statistics and civil defense inadequacies to effectively warn the public of an approaching tsunami.

The tsunami of March 27, 1964. A large tsunamigenic seismic event occurred off the coast of Alaska which hit the Hawaiian Islands on March 27, 1964 (Honolulu Advertiser, March 28, 1964). Island-wide tsunami sirens were sounded at 9 p.m. and over 150,000 people were evacuated from their homes within tsunami inundation zones. Traffic congestion following the tsunami alert was the principle obstacle to an otherwise orderly and compliant evacuation. "Waikiki streets were deserted within an hour after the alert although dancing continued at some hotel beachside terraces after 10 p.m." (Honolulu Advertiser, March 28, 1964). The only problem with resident compliance in the evacuation of low-lying coastal areas occurred when "Oahu police reported that a number of evacuees on the Windward side wanted to return to their homes before the all-clear was sounded. They were stopped at roadblocks, however, and advised by police to wait until the alert had ended. "They complied. There was no trouble" (Honolulu Advertiser, March 29, 1964). The only Letters to the Editor of note were concerned with imploring the state to build an animal quarantine station on higher ground (Honolulu Star-Bulletin, April 1, 1964).

A newspaper article, "Four Years After The Wave", which appeared on May 23, 1964 on the fourth anniversary of the devastating 1960 Hilo tsunami, noted that many advances had been made in the tsunami warning system:

> Hilo's danger zone was evacuated "practically 100 per cent," says (Myron) Isherwood (Director of the Hawaii Island Civil Defense). Civil defense and law enforcement officials have pushed for ordinances which would put teeth into evacuation procedures during wave alerts. One now under consideration, would make it illegal to loiter in any public area subject to wave action."

Other tsunami related articles were primarily concerned with the status and cost of the proposed Hilo breakwater. No articles concerning the risk perception of tsunamis were noted in any Hawaii newspapers.

The tsunami of November 29, 1975. A locally generated tsunami occurred off the coast of the Island of Hawaii on November 29, 1975 which resulted in one person killed, one missing and 13 injured. An article "What tsunami? Alert system told little." appeared in both the Honolulu Advertiser and Honolulu Star-Bulletin on November 30, 1975. This article addressed the need for a more effective regional warning system for locally generated tsunamis. Concomitantly, Hawaii County did receive a $250,000 Federal grant to improve the tsunami warning system.

A time-line chart demonstrates the relationship between the destructive tsunamis to strike the Hawaiian Islands from 1800 to 1994 with the establishment of tsunami warning centers and systems (see Appendix B, Figure B7). The toll which the tsunami of 1946 brought in terms of human mortality and morbidity, coupled with the amount and cost of property damage, created a public outcry for a better tsunami warning system. As a result of this public interest, the Pacific Tsunami Warning Center was established in 1949 in Ewa Beach, Oahu, Hawaii. Similarly, following the locally generated tsunami which impacted Hawaii in 1975, a regional warning system was established.

The tsunami of May 7, 1986. The lead headline of the Honolulu Advertiser on May 8, 1986 was "Hawaii braced for THE wave, but 'lucked out' with wavelets." A seismic event off the coast of Alaska generated a mini-tsunami; however, the resultant traffic jam created by evacuating residents created a "tsunami of a headache" for Civil Defense. The inopportune release of state, county and private business employees coupled with technical problems with the Emergency Broadcast network resulted in "botched" evacuation procedures (many people were in traffic jams located within "tsunami danger zones") and in diminished public perception of the effectiveness of Civil Defense to warn the public of an approaching tsunami in a timely and efficient manner.

Newspaper articles such as "It was Party Time as Isles Awaited Wave", "Tsunami" left thousands stuck in hot buses" and "Big Island, Kauai road woes cited" expressed the reaction of people who experienced this mini-tsunami (Honolulu Advertiser and Honolulu Star-Bulletin, May 8, 1986). Big Island Civil Defense Administrator, Harry Kim, stated that "inundation zones were evacuated within two hours of the tsunami warning", but he was alarmed at the traffic jams in Hilo and Kona. The worst traffic jam-up occurred in Kona along a six mile stretch of Alii Drive. Oddly enough, an article which appeared the year previously noted: "... In 1960 about 400 to 500 people lived along Alii Drive on Kona's coastline. Today there are an estimated 6,000 residents, most of them unfamiliar with tsunamis" (Honolulu Advertiser, November 10, 1985).

George Pararas-Carayannis, former Director of the International Tsunami Information Center, in response to public criticism focusing on the management of this "non-event" tsunami was quoted as saying, "Someday we may have the proper instrumentation to predict tsunamis (precisely) ... but until then experts will have to rely on available science. We're damned if we do and damned if we don't" (Honolulu Advertiser, May 8, 1985).

The tsunami of October 4, 1994. A strong undersea earthquake off the coast of Hokkaido, Japan prompted Civil Defense to issue a tsunami warning for the State of Hawaii. Newspaper articles noted that Honolulu had turned into a ghost town as thousands evacuated the shore areas (Honolulu Star-Bulletin, October 4, 1994). Some articles were concerned with "fear, to caution, to blithe unconcern" of residents; however, more disturbingly, many visitors apparently "strolled the street and acted as if it were a regular day" (Honolulu Star-Bulletin, October 4, 1994). Mayor-elect Jeremy Harris decided to sound the tsunami sirens four hours before the tsunami was to hit to keep people from going to work thereby preventing a greater traffic problem (Honolulu Star-Bulletin, October 5, 1994). Dr. Daniel Walker, an Institute of Geophysics scientist noted that:

> For some strange reason, the tsunami nemesis has just shut off for the last 30 years. As a result, we have a second generation of children, teachers and people who know little about tsunami hazards. ... the tsunamis dangers are intensified by the state's growth since the 1960s, and we have more unattended children at the beach, and they don't know very simple concepts about tsunami hazards (Honolulu Star-Bulletin, October 5, 1994).

This was the second mini-tsunami to impact the state in eight years, and more importantly, over 35 years have passed since the last destructive tsunami hit the Hawaiian Islands. An article in The Honolulu Advertiser on October 9, 1994 noted that the "Next alert may be a big one: Study predicts huge Aleutians quake by 1996 that may set off real tsunami." This article addressed the difficulties faced by scientists when forecasting tsunamis but not the erosion of tsunami risk perception by the public following yet another "non-event."

Sociodemographic Characteristics of the Jury Pool

Age and gender. The random sample of the jury pool (n = 357) studied for this dissertation consists of a rather equal distribution of males (49.2%) and females (50.8%) as compared to the State's 1990 census indicating that the population of Oahu is comprised of 50.9% males and 49.1% females. The median age of the survey respondents is 42.5 years. However, unlike the Ward Research survey, the sample of the jury pool when compared to the State's 1990 census was approximately 3% overrepresented for those respondents 35 years of age or under, whereas the sample for those respondents 35 years of age or older (35-75) was approximately 25% greater than the State's 1990 census (see Appendix A, Table A5; Appendix B, Figure B10).

Language spoken at home. The typical sample respondent speaks English at home (94.5%). Of the remaining 5.5%, languages represented were: Ilocano (5), Chinese (4), Korean (2), Lao (2), Cantonese, (1), Hindi (1), Filipino (1), Samoan (1), Tagalog (1) and Vietnamese (1).

Marital status. The marital status of the sample respondents compared with the State's 1990 census for those survey respondents who are either single or married, is approximately 1.7 to 3.4% greater respectively. The percentage of widows(ers) for the sample is approximately 4.2% less than the State's 1990 census for this marital group while those survey respondents who are separated is approximately equal to those who are separated in the State's 1990 census (7.6% and 7.7%, respectively) (see Appendix A, Table A6; Appendix B, Figure B11). However, when the data were collapsed to help achieve cell and marginal counts of 5 or more, those survey respondents who were self classified as widows(ers) and/or separated were included in the single group.

Presence or absence of dependent children and/or elderly people. The presence or absence of dependent children living in the respondent's household was fairly evenly distributed at 48.2% and 51.8% respectively. The presence or absence of elderly people living in the respondent's household was 16.7% and 83.3% respectively. Thus, 51.8% of the survey respondent's did not have children living in their homes, while 83.3% of survey participants did not have elderly people living in their households.

Educational attainment. The median educational attainment of the sample consists of "some college" (21.8%), which is only 1.6% greater than the State's 1990 census. However, the number of sample respondents who have attained a college or graduate degree is 16.4% greater than the State's 1990 census. Those respondents who have an educational level of 12th grade or less is 27.0% less than the State's 1990 census (see Appendix A, Table A7; Appendix B, Figure B12). Those respondents who have attained a community or technical college education are 9.1% greater than the State's 1990 census. Again it must be emphasized that the State's 1990 census may not reflect the changing demographics of the sample taken in 1995.

Total family income. The median total family income for the sample respondents is between $50,000 to $74,999 which is an increase of 8.7% than the State's 1990 census income group of the same category (see Appendix A, Table A8; Appendix B, Figure B13). The sample's total family income for those respondents who made less than $24,999 was 14.4% less than the State's 1990 census whereas the percentage of survey respondents who earned $25,000 or greater was 14.5% greater than the State's 1990 census. Thus, those survey respondents who earned less than $24,000 were underrepresented by 14.4% in this survey while those respondent's who earned $25,000 were overrepresented by 14.5% in this survey.

Length of residency. Approximately, 80.7% of the sample respondents have resided in Hawaii for over 18 or more years while 19.3% of the respondents having lived in Hawaii for less than 18 years (see Appendix F). The decision to categorize the residency in Hawaii of the survey respondents was originally categorized into 5 categories, as obtained from the National Crime Survey Questionnaire; however, when the data was statistically analyzed using these categories no Chi-Square values were statistically significant because of a lack of cell size.

Geographic distribution. All six geographic Civil Defense districts were represented in the sample with 46.0% of the sample respondents residing in District 1 (see Appendix A, Table A9; Appendix B, Figure B14). The largest difference between the sample and State's 1990 census was 12.2% which occurred in District 6. Overall the sample versus the State's 1990 census coincided quite closely with each other with only a 0.5% difference in overall population distribution.

Religious preference. The religious preference of the sample respondent was predominately Christian (71.2%) and about 14.2% indicated that they were Buddhist (see Appendix A, Table A10; Appendix B, Figure B15). There are no comparable State of Hawaii 1990 census statistics for these categories. The State 1990 census delineates religious preference according to church membership for selected denominations. However, it should be considered that not all sample respondents who identified a particular religious preference actually are church members as would be reflected in the State's statistics.

Race/Ethnic identification. The self-identified racial or ethnic identification of the typical sample respondent was Asian (55.5%), followed by Caucasians (16.6%), Pacific Islanders (14.7%), and Others (14.7%) (see Appendix A, Table A11; Appendix B, Figure B16). However, unlike the Ward Research survey, the sample of the jury pool when compared to the State's 1990 census was approximately 12.3% overrepresented for those respondents of Japanese ancestry (33.3%), whereas Caucasians were underrepresented (9.3%). Sample respondents of Hawaiian and Part Hawaiian ancestry comprised 12.3% which was 5.1% lower than the State's 1990 census statistics. African Americans comprised 0.6% of the sample respondents which is only 1.2% less than the State's 1990 census.

Cognitive and Emotional Characterization of Survey Respondents'in Relation to 12 Risk Perception Categories and the Sociodemographic Influences on Survey Respondents' Risk Perception Beliefs and Attitudes Concerning Tsunamis

Voluntariness of risk. The first research question concerned whether or not survey participants agree that people place themselves at risk for injury by tsunamis because of their own actions. Approximately, 70.4% of the respondents either strongly agreed or agreed, while only 14.3% strongly disagreed or disagreed. Only 15.2% of the participants indicated that they were undecided (neither agree nor disagree) on the question of voluntariness (see Appendix F).

Chi Square analysis of the data revealed that marital status [X^2 (4, n = 354) = 13.66, p < .05] , as well as the presence or absence of elderly people in the household [X^2 (12, n = 352) = 33.70, p < .05], was significantly related to how the survey participants responded to this question. Those respondents who were married held stronger views on the issue, both positively and negatively, than did the people who were single. The exception to this was that those people who were single were far more likely indicate that they were undecided (neither agree nor disagree) (64.2%) on this issue than their married counterparts (35.9%). The presence or absence of elderly people living in the respondents' household greatly determined the voluntariness of injury from a tsunami. If the respondents did not have elderly people living in their homes, a number (70.8%) either strongly agreed or agreed that the risk for injury was voluntary while only 9.1% who did have elderly people living in their homes expressed this opinion. For all categories of this question, those who did not have elderly people living in their homes expressed an opinion that was approximately 3 times stronger than those who did have elderly people living in their homes. The Cramer's V for both marital status and elderly people were .20 and .18 respectively. However, the amount of variation noted in the dependent variable was only weakly correlated with the risk perception independent variables (see Appendix A, Table A16). (Please Note: All of the Chi Square values and Pearson Correlation Coefficients for the sociodemographic variables reported in this Chapter are exclusively for the collapsed variables as noted in the Methodology Chapter. Statistical significance for the Pearson Correlation Coefficients were not different for the collapsed versus non collapsed variables: however, this was not true for Chi Square analyses of the same data.)

A Pearson Correlation Coefficient ($\underline{r}$) analysis of this survey question revealed only weak correlations, predominately with the independent variables which are concerned with the amount of knowledge known about tsunamis by science ($\underline{r}$ =.18), government ($\underline{r}$ =.17) and whether or not the person should protect themselves in the event of a tsunami ($\underline{r}$ =.22). However, when the Pearson Correlation Coefficient is squared ($\underline{r}^2$), these risk perception independent variables only account for a minuscule amount of variation noted in the dependent variable ($\underline{r}^2$ =.03, .03 and .05, respectively) (see Appendix A, Table A16).

The 11.5% of the survey participants who knew someone who they felt had put themselves in danger during the October 4, 1994 tsunami listed overwhelmingly that going to the beach to watch the tsunami arrive (n = 15) was the most "stupid" activity. Other actions which these respondents felt placed someone they knew in danger during the October 4, 1994 tsunami were staying at a workplace (voluntarily or involuntarily) which was located within an evacuation zone (n = 6), surfing (n = 7), staying in their house which was located within an evacuation zone (n = 10), fishing on the coast (n = 1), “wandering” tourists within inundation zones (n = 1) and one respondent felt that television broadcasters had placed themselves in danger covering the event while at the beach. As stated previously, a large number of survey respondents were unsure of where evacuation zones are located; however, 16 survey respondents had indicated that people had put themselves at danger by either staying at work or home in tsunami evacuation zones which indicates that these people believe they know the difference between an evacuation zone and a nonevacuation zone.

Chi Square analysis of this dependent variable with the independent variables did not reveal any statistically significant associations. The Pearson Correlation Coefficient demonstrated only weak correlations ($\underline{r}$ =.11 to .14, $\underline{r}^2$ =.01 to .02) with the risk perception independent variables (see Appendix A, Table A16).

<u>Ease of reduction of risk.</u> Survey participants were questioned as to how easily the risks from tsunamis can be reduced. Approximately 43.8% stated "somewhat easily", while 35.2% felt that the risks could "not be reduced easily". Approximately, 17.6% of the respondents expressed the opinion that the risks could be "very easily reduced", while 3.4% expressed the opposite opinion (see Appendix F).

Chi Square analysis of the data revealed that age [X^2 (8, n = 345 = 15.77 p < .05], as well as length of residency [X^2 (4, n = 344) = 10.51, p < .05], was significantly related to how the survey participants responded to this question.

When this dependent variable was examined for correlations with the independent variables, the Pearson Correlation Coefficient demonstrated only weak correlations ($\underline{r}$ =.11 to .21, $\underline{r}^2$ =.01 to .04) with these risk perception independent variables. The two independent variables which demonstrated the "highest" of the weak correlations were associated with how much control individuals have in what will happen to them if they are exposed to a tsunami and whether or not death can be avoided in the event of a tsunami (see Appendix A, Table A16).

<u>Newness of risk.</u> The determination as to the familiarity of tsunami risks by the survey respondents revealed that 35.8% declared the risks from tsunamis were neither "new nor old", while 40.0% answered that the risks were "very new" or "somewhat

new". Only 24.2% of the participants answered that the risks were "somewhat old" or "very old" (see Appendix F).

Chi Square analysis of this dependent variable with the risk perception independent variables demonstrated statistically significant associations with educational attainment [X^2 (12, n = 352) = 22.91, p < .05] and age [X^2 (8, n = 343) = 24.69, p < .05] variables. While most of the educational categories demonstrated that the experience with tsunamis is neither "new nor old" to them, those who held a college degree were also more likely to express that their experience is somewhat new to very old (28.7% and 40.6%, respectively) but not very new (5.6%), whereas those who hold a grade school education (1-12th grade) were more apt to express that their tsunami experience was very new (24.0%) to them. The Cramer's V suggests that only 15% of the variation in the tsunami experience is associated with educational attainment. When tsunami experience was measured by the 5 scale Likert scale none of the categories was statistically significant because 60% of the cells had counts less than 5 (see Appendix F). However, the category of neither new nor old (38.1%) was the modal category for the > 18 years length of residency category while somewhat new (48.5%) was the modal category for the < 18 year category. The longer the survey participants indicated that they have lived in the Hawaiian Islands the more apt they would be to have been exposed to a tsunami.

The Pearson Correlation Coefficient demonstrated only weak correlations (r =.12 to .21, r^2 =.01 to .04) with the risk perception independent variables. The most notable of the independent variables to have a correlation with tsunami experience was the length of residency (r =.19) and knowledge of the health consequences should the respondent be exposed to a tsunami (r = -.21) (see Appendix A, Table A16). The statistical significance remained the same for Pearson Correlation Coefficient whether or not the data were or were not collapsed as previously mentioned.

Knowledge about risk. The survey participants were questioned as to how well the risks from tsunamis are understood, or known, by science and the government respectively. The responses given by the survey participants were remarkably similar for both of these questions. Respondents expressed their opinion that the risks from tsunamis are “definitely” or “probably understood” by science (86.4%) and “probably known” or “definitely known” by the government (90.4%). For both of these questions, the response of “probably not understood” or “definitely not understood”, as well as “probably not known” or “definitely not known” was 4.0% and 0.6% respectively. Approximately, 94.1% of indicated that they had no experience with a destructive tsunami, while only 5.9% had experienced a destructive tsunami (see Appendix F).

Chi Square analysis for botn of these questions demonstrated only one statistically significant value for the risk from tsunamis known to the government dependent variable and whether the respondent had personally experienced a tsunami. The independent variable of marital status had a curious effect on the respondents' perception as to the state of knowledge that the government possesses concerning the risks posed by tsunamis to the population [X^2 (4, n = 353) = 13.85, $p < .05$]. Married respondents were more than 2 times more likely to express that the risks from tsunamis are definitely known by the government than those respondents who were single (26.6% and 13.3% respectively). However, those respondents who were single were more “hesitant” than their married counterparts to express that the government “neither knows nor not knows” the risk posed by tsunamis to the population by almost 4 to 1 (4.0% and 1.1% respectively). Cramer's V suggests that approximately 20% of the variation found in the dependent variable is associated with marital status. The independent variable which was associated with a respondents' personal experience with a destructive tsunami was marital status. Of the 21 people who had experienced a destructive tsunami, approximately 81% were married, while only 19% were single (see Appendix A, Table A16).

A Chi Square association with the variable of personal experience with a tsunami indicated a relationship with age [X^2 (2, n = 348) = 5.87, $p < .05$]. Respondents greater than 18 years of age indicated that they had personally experienced a tsunami.

The Pearson Correlation Coefficient demonstrated low to moderate correlations ($\underline{r}$ =.11 to .56, $\underline{r}^2$ =.01 to .31) with the risks from tsunamis understood by science with the risk perception independent variables. The most notable of the independent variables to have a correlation with how well science understands the risks posed by tsunamis was with how well the risks posed by tsunamis are known by the government ($\underline{r}$ =.56, $\underline{r}^2$ =.31). Other variables which are low to moderately correlated with the risks from tsunamis understood by science were the frequency of tsunamis around the world ($\underline{r}$ =.25, $\underline{r}^2$ = .06), how much damage would be done if a tsunami were to hit the Hawaiian Islands ($\underline{r}$ =.31, r^2 = .10), respondent fear of tsunamis ($\underline{r}$ =.20, $\underline{r}^2$ = .04) and the chances of a tsunami occurring in the Hawaiian Islands in the next few years ($\underline{r}$ =.21, $\underline{r}^2$ = .04). The dependent variable, risk from tsunamis known by government, was similarly correlated with how well science understands the risks posed by tsunamis ($\underline{r}$ =.56, $\underline{r}^2$ =.31, respectively). This correlation value mirrored the same value exhibited by how well science understands the risks from tsunamis with the risks from tsunamis known to the government.

Other variables which exhibited low Pearson Correlation Coefficients with the risks from tsunamis which are known to the government were how frequently tsunamis occur around the world ($\underline{r}$ =.19, $\underline{r}^2$ =.04), knowledge as to bodily injury of being exposed to a tsunami ($\underline{r}$ =.20, $\underline{r}^2$ =.04), how much damage would be done if a tsunami was to hit the Hawaiian Islands ($\underline{r}$ =.20, $\underline{r}^2$ =.04) and whether or not people should protect themselves from tsunamis or the government should protect people from the risks of tsunamis ($\underline{r}$ =.19, $\underline{r}^2$ =.04 and $\underline{r}$ =.21, $\underline{r}^2$ =.04 respectively). The Pearson Correlation Coefficient for whether or not the respondent has experienced a destructive tsunami was low to moderately associated with whether the respondent had known someone who had previously experienced a destructive tsunami (r =.31, r^2 =.10) and with the age of the respondent (r =.15, r^2 =.02) (see Appendix A, Table A16).

Exposure to risk. The survey participants were questioned as to how many people in Hawaii can either be injured or killed by tsunamis. The responses given by the sample respondents were remarkably similar for both of these questions. Overwhelmingly, the respondents answered that a lot of people can be injured (69.9%) or killed (61.5%) by tsunamis followed by some 12.4% and 16.0% respectively. Interestingly, some of the survey participants were not able to predict how many people would be injured or killed (i.e., 11.5% and 14.0% respectively) (see Appendix F).

When the survey participants were queried as to whether or not they knew someone who had experienced a destructive tsunami, 80.1% indicated that they did not know anyone who had experienced this type of tsunami, while only 19.9% responded that they did know someone (see Appendix F).

The survey respondents were queried as to whether they are personally at risk from an approaching tsunami when at the beach, surfing, diving or fishing. The majority of respondents (56.2%) expressed the opinion that they are frequently at risk while only 20.3% indicated that they were only sometimes at risk from an approaching tsunami when participating in these recreational activities. Surprisingly, 18.9% of the respondents expressed that they are never or almost never at risk, while 4.5% were unable to determine if they are at risk from an approaching tsunami when at the beach, surfing, diving or fishing (see Appendix F).

Chi Square Analysis demonstrated only one statistically significant association for how many people could be killed by a tsunami with the length of residency in the State of Hawaii [X^2 (3, n = 356) = 11.13, $p < .05$]. The data reveal that those respondents who have resided in the State for over 18 years were more likely to estimate the number of people who could be killed by a tsunami by factor of five times greater than those who have resided in Hawaii for less than 18 years. However, this factor was decreased by a factor of three for those respondents who could not predict the amount of potential deaths and responded to the don't know category. It must be noted that the Cramer's V (.18) for this Chi Square indicates a low association between the two variables (see Appendix A, Table A16).

The independent variables of age [X^2 (2, n = 347) = 13.21, p < .05], marital status [X^2 (1, n = 355) = 8.43, p < .05], education [X^2 (3 n = 356) = 9.03, p < .05], and income [X^2 (2, n = 347) = 10.57, p < .05] demonstrated statistically significant Chi Square associations with those respondents who knew someone who experienced a destructive tsunami. Those respondents who were married were 3 times more likely to know someone who had experienced a destructive tsunami than a person who was single (14.7% and 5.4% respectively). The more advanced the educational attainment of the respondent, the more likely the person is to know someone who has experienced a destructive tsunami. Those individuals who earn between $25,000 to $74,999 are more likely to know someone who has experienced a destructive tsunami. Those respondents who are within the 36 to 75 year age category have a 2 to 3 times greater chance of knowing someone who has experienced a destructive tsunami than those respondents under 36 years of age (see Appendix A, Table A16).

A Chi Square statistically significant association was demonstrated with whether or not a respondent felt that they are personally at risk from an approaching tsunami when they are at the beach, surfing, diving or fishing with respondents' age [X^2 (8, n = 345) = 15.77, p < .05] and the length of residency [X^2 (4, n = 344) = 10.51, p < .05] in the State of Hawaii . Those respondents that fall within the "middle adult" category (36-50 years of age) are 1.5 to 3.5 times more likely to feel that they are more frequently at risk than those respondents under 36 and those above 50 years of age. However, those participants who are below age 36 are 1.5 times more likely to express that they are never at risk when at the beach, surfing, diving or fishing than those respondents who are over 36 years of age. Those individuals who have resided in the State of Hawaii for 18 years or more are 4.5 times more likely to state that they are at risk than those individuals who have resided in Hawaii for less than 18 years. Paradoxically, those people who have lived in the State for over 18 years also demonstrated, by a factor of 6, that they are almost never at risk when performing these activities as compared with those who have resided in the State for less than 18 years (see Appendix A, Table A16).

The Pearson Correlation Coefficient demonstrated low to moderate correlations (r =.11 to .67, r^2 =.01 to .45) with how many people could be injured from tsunamis with the risk perception independent variables. The independent variables of fear of tsunamis, avoidance of death from tsunamis and the number of people who could be killed by tsunamis, demonstrated the highest correlations (r = -.20, r^2 =.04, r =.22, r^2=.05 and r =.67, r^2 =.45 respectively). The Pearson Correlation Coefficients for how many people could be killed in the event of a tsunami were correlated with how often tsunamis happen around the world (r =.19, r^2 =.04), can you avoid injury (r =.18, r^2 =.03), how many people can be injured by tsunamis (r=.67, r^2 =.45) and can you avoid death if you should be exposed to a tsunami (r =.26, r^2 =.07) (see Appendix A, Table A16).

The Pearson Correlation Coefficients relating the dependent variable of knowing someone who had experienced a destructive tsunami with other risk perception independent variables have presented questionable correlations with how much knowledge the respondent has of the potential occurrence of tsunamis in months (r =.15, r^2 =.03) and years (r =.16, r^2 =.03) and whether or not the person understands the difference between a local and a distal tsunami (r =.13, r^2 =.02). Curiously, knowing someone who has experienced a destructive tsunami is correlated with whether or not construction should be limited within inundation zones to protect the risk to future generations from tsunamis (r = -.11, r^2 =.01) (see Appendix A, Table A16).

The independent variables which are concerned with proximity to the ocean (e.g., pass through an inundation zone to or from work, while at home or when at the beach) exhibited a low correlation with potential tsunami impact when at the beach, surfing, diving or fishing (r =.23, r^2 =.06; r =.25, r^2 =.06 and r =.26, r^2=.07, respectively). The independent variables of how much damage would occur in the Hawaiian Islands should a destructive tsunami impact the State, how many people can be killed in the event of such a tsunami, and whether or not the respondent fears tsunamis all demonstrate low correlations with the dependent variable (r =.20, r^2 =.04; r =.20, r^2 =.04 and r =.19, r^2 =.04, respectively) (see Appendix A, Table A16).

Control over risk. This risk category defines respondent conceptions as to their control of what will happen to them if exposed to a tsunami and the concomitant possibility of avoiding injury and death. When the survey participants were queried as to their ability to control what will happen to them if they are exposed to a tsunami, the distribution was almost even between those who felt they could control with those who felt they could not control what happens to them (46.0% and 38.4%, respectively), while only 15.2% of the respondents were unsure as to whether or not they could control "fate". However, the respondents were not so evenly divided when it came to the issues of whether or not they could avoid injury or death should they be exposed to a destructive tsunami. Respondents indicated that they "could avoid injury" at a rate of almost 1.5 times more than those who determined they "could not avoid injury" (48.7% and 29.6%, respectively), while the percentage of those who indicated they "could avoid death" was almost 2 times greater than for those who felt they "could not avoid death" (56.9% and 26.4%, respectively). The percentage of respondents who were unsure as to their ability were approximately equal for both questions (21.7% and 26.6%) (see Appendix F).

The survey respondents were queried as to whether they themselves or the government is responsible for protecting the individual from a destructive tsunami. The participants strongly agreed that they should be responsible for their own safety versus the government by a slight margin (58.1% and 48.7% respectively). More people indicated that they "strongly agreed" that people should protect themselves versus those who just "agreed" (58.1% and 36.2% respectively). However, the respondents were evenly divided when it came to determining whether the government should protect people from destructive tsunamis (48.7% strongly agrees versus 43.1% agree). Approximately 2.5% of respondents to both questions indicated that they either disagreed or strongly disagreed with whether or not the individual or government should protect them from destructive tsunamis, while only approximately 4% were undecided (neither agree nor disagree) in their response (see Appendix F).

When the survey participants were questioned as to whether people should be forced to evacuate their homes located within an evacuation zone when a tsunami warning had been issued, over 67.5% indicated that people should be evacuated, while only 20.7% answered that they should not be forcibly evacuated, with 11.8% indicating that they don't know (see Appendix F). While the term evacuation zone was incorrectly defined by approximately 50% of the survey respondents at the beginning of the questionnaire, the response to this question may indicate that a "sensitization effect" may have alerted the respondents as to the meaning of this term as the questionnaire progressed (see Appendix F).

Chi Square Analysis demonstrated a statistically significant association between the ability to avoid death should an individual be exposed to a tsunami and the age of the respondent [X^2 (10, n = 344) = 19.62, $p < .05$]. Those participants who are categorized as "middle adults" (36-50 years of age) were more likely to indicate that they "probably" or "definitely" can avoid death when compared with "younger" and "older adults" (26.7%, 18.6% and 11.6% respectively) (see Appendix A, Table A16).

Statistically significant associations were obtained for whether or not individuals should be forcibly evacuated from their homes located within an evacuation zone when a tsunami warning has been issued with marital status [X^2 (2, n = 356) = 9.60, p < .05], length of residency [X^2 (2, n = 357) = 5.99, p < .05] and race - ethnicity [X^2 (6, n = 357) = 12.72, p < .05]. Those respondents who are married were 1.7 times more likely to indicate that people should be forcibly evacuated than those who are single (42.7% and 24.7% respectively). However, those participants who are single were 1.3 times more likely to feel that people should not be forcibly evacuated than their married counterparts. Only 11.8 % of single and married respondents were noncommittal in their opinion on this subject (see Appendix A, Table A16).

Those respondents who have been residents of the State of Hawaii for more than 18 years were approximately 5 times more willing to have people forcibly evacuated from their homes should a tsunami warning be issued than those individuals who have been residents for less than 18 years (82.6% and 17.4% respectively). Similarly, those participants who have been residents for more than 18 years were 2 times more apt to indicate that they don't know if people should be forcibly evacuated than those who have been resident for less than 18 years residency. Paradoxically, residents of the State of Hawaii for more than 18 years were also 5 times less likely to have people forcibly evacuated from their homes should a tsunami warning be issued than those individuals who have been residents for less than 18 years (82.4% and 17.6% respectively). The modal category; however, was for those residents of greater than 18 years was to have people forcibly evacuated in the event of a tsunami (see Appendix A, Table A16).

Those respondents of Asian ancestry (41.0%) were more willing than Pacific Islanders (9.0%) "Others" (7.8%) and Caucasians (10.1%) to agree to the use of force to evacuate people from their homes should a tsunami warning be issued. However, only 10.2% of those of Asian ancestry, 2.5% of Pacific Islanders, 4.2% of "Others" and 3.1%

of Caucasians felt that force should not be used in the event of a tsunami. Approximately, 3% of each of the race - ethnicity categories indicated that they don't know if people should be forcibly evacuated in the event of a tsunami (see Appendix A, Table A16).

The Pearson Correlation Coefficients for the ability of the respondent to control what will happen to him/her if exposed to a tsunami and the concomitant possibility of avoiding injury and death were all either moderately or highly correlated with one another. Control over what will happen to individuals should they be exposed to a tsunami was moderately correlated with how much a person could either avoid injury (r =.70, r^2 =.49) and only lowly with death (r =.39, r^2 =.15). The variables of how easily the risks from tsunamis can be reduced and the chances of a tsunami occurring in Hawaii in the next few months demonstrated low correlations with control (r =.22, r^2 =.05 and r =.19, r^2 =.04 respectively). The ability to avoid injury should the respondent be exposed to a tsunami was correlated with control of what will happen to the individual (r =.66, r^2 =.44), ability to avoid death (r =.49, r^2 =.24), how many people could be killed by a tsunami (r =.19, r^2 =.04) and the chance of a tsunami occurring in Hawaii in the next few months (r =.22, r^2 =.05) and years (r =.19, r^2 =.04). The independent variables which are correlated with the ability to avoid death should the respondent be exposed to a tsunami are the capability of controlling what will happen (r =.40, r^2 =.16), ability to avoid injury (r=.49, r^2 =.24), the ease of tsunami risk reduction (r =.20, r^2 =.04), how many people are injured in Hawaii (r =.22, r^2 =.05), how many people could be killed (r =.26, r^2 =.07) and the chances of a tsunami occurring in Hawaii in the next few months (r =.22, r^2 =.05) (see Appendix A, Table A16).

The Pearson Correlation Coefficients for whether or not individuals or government should be responsible for protecting them(selves) from tsunamis demonstrated low to moderate correlations with similar independent variables. Those respondents who indicated that people should protect themselves from the risk of tsunamis correlated with the quantity of people who could be hurt should a tsunami impact Hawaii (*r* =.22, r^2 =.05), whether or not the government should protect people from tsunamis (*r* =.66, r^2 =.44), the limitation of construction within inundation zones to protect the safety of future generations (*r* =.20, r^2 =.04), and the fear of tsunamis (*r* =.24, r^2 =.06). Likewise, for those respondents who indicated that the government should protect people from the risks of tsunamis, the independent variables exhibited low to moderate correlations with how much is known by the government about tsunamis (*r* =.21, r^2 =.04), whether or not people should protect themselves from tsunamis (*r* =.68, r^2 =.46), the limitation of construction within inundation zones to protect the safety of future generations (*r* =.29, r^2 =.08), the cost of limiting construction within inundation zones to protect the safety of future generations (*r* =.24, r^2 =.06), the fear of tsunamis (*r* =.30, r^2 =.09) and whether or not people should be forcibly evacuated from their homes should a tsunami warning be issued (see Appendix A, Table A16).

Low correlations were demonstrated as to whether people should be forcibly evacuated from their homes should a tsunami warning be issued with how much the government knows about the risks form tsunamis (*r* =.20, r^2 =.04), the fear of tsunamis (*r* =.19, r^2 =.04), how much damage would occur to the Hawaiian Islands should a destructive tsunami impact the state (*r* =.22, r^2 =.05) and the respondents' perception of the risk from tsunamis when they are at the beach, surfing diving or fishing (*r* =.19, r^2 =.04) (see Appendix A, Table A16).

Dread of risk. The survey respondents were questioned as to whether or not they "feared" tsunamis. The response for 40.3% of the participants was that they feared tsunamis only somewhat while those who feared tsunamis a great deal were evenly divided with those who responded very little at 23.3% and 23.8%, respectively. Only 12.6% of the sample respondents were not afraid or non committal in their fear of tsunamis (see Appendix F).

The dread of tsunamis was also investigated by questioning the sample respondents as to whether or not they "think" about tsunamis when they are at the beach, surfing, diving or fishing. Surprisingly, 76.8% of the respondents indicated that they never, or almost never, think about tsunamis when they are participating in these activities, while only 20.4% of the respondents thought about tsunamis sometimes or frequently (see Appendix F).

Chi Square analysis of the "fear" of tsunamis suggests that the presence or absence of dependent children in the household [X^2 (4, n = 357) = 16.20, p < .05], educational attainment [X^2 (12, n = 357) = 25.48, p < .05], religious identification [X^2 (2, n = 357) = 51.35, p < .05]and the race - ethnicity [X^2 (12, n = 357) = 24.29, p < .05] of the respondent does have a statistically significant association. The presence or absence of dependent children in the household appears to influence the respondents "fear" of tsunamis. Approximately, 73.3% of those households with dependent children feared tsunamis a great deal or somewhat, while those households with no dependent children were, more or less, equally divided on the issue with 54.6% indicating that they feared tsunamis a great deal or somewhat while 43.8% very little or not at all (see Appendix A, Table A16).

The educational attainment of the survey participants indicated that 75.0% with an educational attainment of 12 years or less feared tsunamis a great deal or somewhat while only 20.8% feared tsunamis very little or not at all. Surprisingly, with increasing educational attainment, the responses appear to even out between either fearing a great deal or somewhat or very little or not at all. For those with a college degree, 54.8% indicated that they feared tsunamis a great deal or somewhat, while 43.8% stated very little or not at all. The trend toward decreasing fear of tsunamis with increasing educational attainment was also noted for those with a community or technical college and college degree (see Appendix A, Table A16).

The religious identification of the survey participants indicated that Buddhists and Roman Catholics were quite similar in their fear of tsunamis with approximately 70% fearing tsunamis a great deal or somewhat while approximately 23% indicating very little or not at all. Interestingly, those respondents who indicated religious affiliation with "Other" or Protestantism were more evenly divided between fearing tsunamis a great deal or somewhat (55.7%) with very little or not at all (43.1%). Buddhists were somewhat more noncommittal as to their fear of tsunamis (8.0%) than the other religious categories (see Appendix A, Table A16).

The self-identified racial - ethnic categories of the survey participants indicated that Asians and Pacific Islanders have similar fear of tsunamis a great deal or somewhat (68.9 and 66.0% respectively) and very little or not at all (28.2% and 34.0%, respectively). However, those who indicated their racial identification as Caucasian were rather evenly split between a great deal or somewhat (47.5%) with very little or not at all (42.5%), while those of the "Other" racial - ethnic category mirrored the Asian and Pacific Islanders fear of tsunamis (i.e., a great deal or somewhat [59.6%] with very little or not at all [38.5%]) (see Appendix A, Table A16).

The Pearson Correlation Coefficient for the "fear of tsunamis" indicates that a correlation exists with how much is understood about tsunamis by science (r =.20, r^2 =.04), whether or not the respondent fears tsunamis while at the beach (r =.20, r^2 =.04), thinks about tsunamis while at the beach, surfing, diving or fishing (r =.44, r^2 =.19), whether or not the respondents indicate that people (r =.24, r^2 =.06) or the government (r =.30, r^2 =.09) should protect them from tsunamis, the effect on future generations as to safety (r =.40, r^2 =.16) or cost (r =.35, r^2 =.12), how much damage could result from a destructive tsunami in the Hawaiian Islands (r =.31, r^2 =.10) and with whether or not a respondent should be forcibly evacuated from their homes once a tsunami warning had been issued (r =.20, r^2 =.04) (see Appendix A, Table A16).

Coefficients for the variable which measures the respondents "thinking" about tsunamis when at the beach, surfing, diving or fishing are correlated with how often tsunamis occur throughout the world (r =.20, r^2 =.04), the effect on future generations as to safety (r =.27, r^2 =.07) or cost (r =.23, r^2 =.05), fear of tsunamis (r =.44, r^2 =.19), the potential for future tsunamis in months (r=.26, r^2 =.07) or years (r =.23, r^2 =.05), the amount of damage a tsunami can produce in the Hawaiian Islands (r =.23, r^2 =.05), as well as whether or not people should be forcibly evacuated from their homes once a tsunami warning had been issued (r =.19, r^2 =.03) (see Appendix A, Table A16).

Future generations and contact with risk. The survey participants were questioned as to whether or not the safety and cost to future generations should be achieved by limiting construction within evacuation zones. (As previously noted a problem could exist with the analysis of this question which depends on whether or not the respondent understands the definition of an evacuation zone. As was noted previously, 212 respondents (59%) were not able to answer question 3 correctly; however, for those who were not able to answer this question correctly approximately 61% were able to answer question 14 which indicates that the respondent learned the correct meaning of an evacuation zone as he or she progressed through the questionnaire. For the description of these two variables it will be assumed that the respondents do know the correct interpretation of an evacuation zone). The response to both of these questions was remarkably similar. The safety and cost to future generations was endorsed by those who indicated that they agreed or strongly agreed (60.2% and 55.2%, respectively) and less so with those who disagreed or strongly disagreed (16.5% and 18.8%, respectively) (see Appendix F).

Chi Square analysis of these two variables indicated that only the safety to future generations was associated with educational attainment [X^2 (12, n = 356) = 37.32, $p < .05$] and religious preference [X^2 (12, n = 350) = 24.64, $p < .05$] while cost considerations was associated only with religious preference [X^2 (12, n = 344) = 21.55, $p < .05$]. Those respondents who had an educational attainment of a grade school level (1-12) were far more likely to agree or strongly agree that the safety to future generations from tsunamis should be achieved by limiting construction within evacuation zones (78.9%) while only 9.8% of this group disagreed or strongly disagreed with this decision. With advanced educational attainment beyond a grade school education (community or technical college, some and college degrees) approximately 49.8% agree or strongly agree that construction should be limited in evacuation zones while approximately 18.6% disagreed or strongly disagreed (see Appendix A, Table A16).

The religious identification of the survey participants indicated that Buddhists and Roman Catholics were quite similar in their opinions about ensuring the safety of future generations by limiting construction within evacuation zones with approximately 68.9% agree or strongly agree while only 11.6% indicating disagreed or strongly disagreed. Surprisingly, those respondents who indicated religious affiliation with "Other" or Protestantism demonstrated only a 2:1 margin between agree or strongly agree (51.7%) with disagreed or strongly disagreed (21.7%). The "Other" religious group indicated that they were undecided (neither agree nor disagree) as to the safety of future generations (33.7%) than the other religious categories (see Appendix A, Table A16).

The Pearson Correlation Coefficient for ensuring the safety of future generations by limiting construction in evacuation zones was correlated with whether or not the people should protect themselves (r =.20, r^2 =.04) or the government should protect people against tsunamis (r =.29, r^2 =.08), reducing the cost of to future generations by limiting construction within evacuation zones (r =.80, r^2 =.64), whether or not the respondent fears tsunamis (r =.40, r^2 =.16), and how much the respondent thinks about tsunamis when at the beach, surfing, diving or fishing (r =.27, r^2 =.07) (see Appendix A, Table A16).

The Correlation values for the cost to ensure the safety of future generations by limiting construction within evacuation zones is correlated with whether the government should protect people from tsunamis (r =.24, r^2 =.06), ensuring the safety of future generations by limiting construction within evacuation zones (r =.80, r^2 =.64), how much the respondent fears tsunamis (r =.34, r^2 =.12), and how much the respondent thinks about tsunamis when at the beach, surfing, diving or fishing (r =.23, r^2 =.05) (see Appendix A, Table A16).

Catastrophic potential of risk. The survey participants were queried as to how often tsunamis happen in the Hawaiian Islands. Overwhelmingly, the respondents indicated that tsunamis happen only sometimes (67.2%) followed by almost never (26.6%), never (0.6%) and equally between don't know and frequently (each 2.8%, respectively). When the respondents were questioned as to their opinion of how much damage would occur if the Hawaiian Islands were exposed to a large tsunami, their response was primarily probably a lot of damage or definitely a lot of damage (94.7%), while only 4.5% of the participants indicated that they don't know (see Appendix F).

A Chi Square analysis was performed only on the question which concerned the amount of damage to the Hawaiian Islands if they were exposed to a large tsunami. For this dependent variable, no significant associations with any of the independent variables was obtained.

The Pearson Correlation Coefficient for the amount of damage to the Hawaiian Islands following exposure to a large tsunami revealed correlations with how often tsunamis occur throughout the world (r =.25, r^2 =.06), how well tsunamis are understood by science (r=.31, r^2 =.10) and known by government (r =.20, r^2 =.04), whether or not the respondent was at risk when at the beach (r =.30, r^2 =.09), or while thinking about tsunamis when at the beach, surfing, diving or fishing (r =.20, r^2 =.04), the amount of fear the respondent has towards tsunamis (r =.30, r^2 =.09), the chance of a tsunami occurring in months (r =.28, r^2 =.08) or years (r =.33, r^2 =.11) and whether or not residents should be forcibly evacuated from their homes should a tsunami warning be issued (r =.22, r^2 =.05) (see Appendix A, Table A16).

Global catastrophic potential of risk. The sample respondents were questioned as to their conception of how often tsunamis occur around the world. The majority of the respondents indicated that tsunamis happen around the world sometimes (61.6%) followed by frequently (20.3%), don't know (10.2%) and almost never (7.9%). Surprisingly, none of the respondents chose the category that tsunamis occur throughout the world never which was not the case when questioned about how often tsunamis occur in Hawaii (see Appendix F).

Chi Square analysis of the data revealed that the variables of age [X^2 (6, n = 345) = 17.12, $p < .05$] and length of residency [X^2 (3, n = 354) = 8.30, $p < .05$] had an association as to the respondents' conception of how often tsunamis happen throughout the world. Each of the age categories indicated that tsunamis occur throughout the world sometimes (61.6%). However, young adults (61.5%) and middle adults (34.6%) responded that tsunamis occurred around the world almost never, while very few of the older adults (3.9%) indicated this conception, whereas, middle adults (35.3%) and older adults (35.3%) responded that tsunamis occurred around the world frequently, while significantly fewer younger adults (29.4%) expressed this conception (see Appendix A, Table A16).

How long the respondent has resided in Hawaii had an influence on their perception of how often tsunamis occur around the world. Those residents who have lived in the state for more than 18 years indicated that tsunamis occur around the world sometimes (63.2%), followed by frequently (21.4%), almost never (7.4%) and don't know (8.1%). However, the respondents who have lived in the Hawaii for less than 18 years indicated that tsunamis occur around the world sometimes (55.1%) followed by frequently (16.0%), almost never (10.1%) and don't know (18.8%) (see Appendix A, Table A16).

The Pearson Correlation Coefficient for how often do tsunamis occur around the world demonstrated correlations with how often tsunamis happen in Hawaii (r =.23, r^2 =.05), how well tsunamis are understood by science (r =.25, r^2 =.06) and known by government (r =.19, r^2 =.04), whether or not the respondent thought about tsunamis when at the beach, surfing, diving or fishing (r =.20, r^2 =.04), the amount of damage that could occur if the Hawaiian Islands were exposed to a large tsunami (r =.25, r^2 =.06) and the chance of a tsunami occurring in months (r =.31, r^2 =.10) or in years (r =.34, r^2 =.12) (see Appendix A, Table A16).

Immediacy of risk. The survey participants were questioned as to whether they live, work or travel through an evacuation zone and whether their children attend a school within an evacuation zone. The perception of immediacy of risk was also studied as to whether or not the respondents considered themselves at risk from a tsunami (any scenario) and if they knew what would happen to them if they were exposed to a tsunami.

A problem could exist with the analysis of the first two questions in this risk characterization category which depends on whether or not the respondent understands the definition of an evacuation zone. As was noted previously, 212 respondents (59%) were not able to answer question 3 correctly; however, for those who were not able to answer this question correctly approximately 61% were able to answer question 14 which indicates that the respondent learned the correct meaning of an evacuation zone as he or she progressed through the questionnaire. For the description of these two questions it will assumed that the respondents do know the correct interpretation of an evacuation zone.

The risk category which is concerned with the immediacy of risk comprises four questions of the questionnaire. Only 22.1% of the respondents indicated that they lived within an evacuation zone, whereas 73.1% said that they did not", while 4.8% don't know. Survey respondents who were able to correctly identify evacuation zone (n = 145), 80.0% indicated yes they are at risk, whereas 14.9% indicated no while 2.1% indicated that they don't know and 3.4% did not reply to this question. Of those respondents who were not able to correctly identify evacuation zones (n = 212), 63.7% indicated yes they are at risk, whereas 30.7% indicated no while 6.6% indicated that they don't know and 1.4% didn't reply. When the respondents were queried as to whether or not they worked in an evacuation zone, 62.2% indicated that they did not, whereas 34.2% did with only 3.6% responding that they don't know. The respondents were equally divided between whether they do or do not pass through an evacuation zone to or from work (48.2% and 43.4%, respectively), while only 8.4% responded that they don't know. Survey respondents who were able to correctly identify evacuation zone (n = 145), 43.3% indicated that they do pass through an evacuation zone on the way to work, whereas 55.2% do not, while only 0.6% don't know). Most of the respondents indicated that their children do not attend a school located within an evacuation zone (87.9%) whereas, 10.4% indicated that their children do attend school within an evacuation zone, while only 1.8% responded that they don't know (see Appendix F).

Both Chi Square and Pearson Correlation Coefficients were not calculated for variables which were concerned with whether the respondent lived, worked or traveled through an evacuation zone and whether their children attend a school in an evacuation zone because of the confusion as to the location of the evacuation zones exhibited by the survey respondents.

The survey participants were queried as to whether or not they are personally at risk from tsunamis (nonspecific scenario). The data show that 66.9% do not consider themselves at risk from tsunamis while 27.5% do and 5.6% don't know (see Appendix F).

When the participants were queried as to whether or not they knew what will happen to them if they are exposed to a tsunami, 66.9% indicated that they do, while 30.8% do not and 2.3% don't know. For those respondents (n = 237) who answered yes to question 11 (66%) (i.e., Do you know what will happen to you if you are personally hit by a tsunami wave?), only 19 did not write in an actual response. Of the responses obtained for this question the most common reply was death by drowning (n = 143), followed by injury (n = 28), dragged out to sea (n = 26), loss of property (n = 9), hit by debris (n = 5), mercy of the waves (n = 2), chaos (n = 1), get wet (n = 1), homelessness (n = 1), no water or electricity (n = 1) and elimination of HMSA coverage (n = 1).

Chi Square analysis of the data demonstrated that only the variable concerned with personal risk from tsunamis was associated with the variables of the presence or absence of dependent children [X^2 (2, n = 357) = 6.27, $p < .05$] and length of residency in Hawaii [X^2 (2, n = 357) = 12.92, $p < .05$]. The association between the dependent variable and the presence or absence of children is a relatively weak association (Cramer's V = .13). Those who said that yes they are personally at risk represented 25.6%, whereas those who indicated they were not consisted of 68.1% of the respondents, while 6.3% indicated that they don't know.

Of those respondents who have lived in Hawaii for over 18 years, 70.5% indicated that they do not consider themselves to be personally at risk from a tsunami, whereas 25.7% do consider themselves at risk, with only 3.8% responding that they don't know. Of those survey participants who have lived in Hawaii for less than 18 years, 52.2% do not consider themselves to be personally at risk from a tsunami, whereas 34.8% do consider themselves at risk, with 13.0% responding that they don't know.

There were no Chi Square associations between the dependent variable of "do you know what will happen to you if you are exposed to a tsunami" and the risk perception independent variables.

The Pearson Correlation Coefficient for whether or not the survey participant felt he or she was personally at risk from a tsunami demonstrated that correlations exist with "if you live in an evacuation zone are you at risk from a tsunami" (r=.21, r^2 =.04) and if the respondent passes through an evacuation zone to or from work (r=.21, r^2 =.04). The correlations for this dependent variable with other independent variables ranged from (r =.11, r^2 =.01 to r =.15, r^2 =.02) (see Appendix A, Table A16).

Correlations between the variable of "do you know what will happen to you if you are exposed to a tsunami" are demonstrated for how often tsunamis occur around the world (r =.23, r^2 =.05), how well tsunamis are known by the government (r =.20, r^2 =.04) and whether or not the respondent has actually experienced a destructive tsunami (r =.21, r^2 =.04) (see Appendix A, Table A16).

Religiosity and/or spirituality. The survey participants were queried as to whether or not they considered themselves to be a religious or spiritual person. The results indicate that 49.4% of the respondents consider themselves to be a religious or spiritual person, while 25.3% did not, and another 25.3% considered themselves to be only sometimes (see Appendix F).

Chi Square analysis of the data revealed that marital status [X^2 (2, n = 355) = 14.88, p < .05], religious preference [X^2 (16, n = 350) = 59.53, p < .05], and race - ethnicity [X^2 (6, n = 356) = 12.64, p < .05] were associated with the religiosity of the respondent.

Those respondents who are single were more likely to consider themselves a religious or spiritual person (41.2%) and no (23.0%) and sometimes (35.8%), whereas those respondents who are married considered themselves to be predominately religious or spiritual (55.1%) followed by no 27.1% and sometimes (17.9%) (see Appendix A, Table A16).

Respondents who identified as Protestant indicated that they are a religious or spiritual person (68.5%) followed by not (12.0%) and sometimes (19.4%), while those of the Roman Catholic faith considered themselves to be a religious or spiritual person (60.1%) followed by not (15.6%) and sometimes (23.9%). Those respondents who identified themselves as Buddhists indicated they were religious or spiritual (22.0%) followed by not (50.0%), and sometimes (28.9%). Those respondents in the Other category said they were religious or spiritual (28.9%) followed by not (42.2%), and sometimes (28.9%) (see Appendix A, Table A16).

The Pearson Correlation Coefficients for religiosity demonstrated low correlations with the independent variables (i.e., < .30).

Changes in risk. The survey participants were asked their opinion concerning the chances of a tsunami hitting the Hawaiian Islands in the next few months or in the next few years. (Note. The data collection dates for this survey as previously stated was form February 10 - 21, 1995 which was 4 months after the mini-tsunami hit the Hawaiian Islands on October 4, 1994. This may have influenced respondent attitudes toward these questions). The participants indicated that the likelihood that a tsunami would occur in the Hawaiian Islands within the next few months as somewhat likely (28.8%), followed by somewhat unlikely (24.9%), very unlikely (17.6%), don't know (21.6%) and very likely (7.8%). In contrast to the above responses, when the participants were questioned as to the possibility that a tsunami may occur in the Hawaiian Islands within the next few years the largest response was somewhat likely (40.1%), followed by very likely (24.9%), don't know (17.1%), somewhat unlikely (13.4%) and very unlikely (4.5%) (see Appendix F).

A Chi Square analysis of the data revealed that educational attainment [X^2 (12, n = 357) = 21.32, $p < .05$] and religion [X^2 (12, n = 351) = 22.71, $p < .05$] was associated with respondent's feelings that there would be an occurrence of tsunamis in the Hawaiian

Islands in the next few months and next few years while only religious preference was associated with occurrence of tsunamis in Hawaii in the next few years [X^2 (12, n = 357) = 20.67, p < .05] (see Appendix A, Table A16).

Those respondents who attained an educational level of 12 years or less indicated that the occurrence of a tsunami in the Hawaiian Islands in the next few months is somewhat unlikely or very unlikely (29.2%) and very likely or somewhat likely (36.1%); however, as the respondents' educational attainment increases (college degree), these values change to somewhat unlikely or very unlikely (56.1%) and very likely or somewhat likely (33.6%). The respondents' conception of the occurrence of a tsunami in the next few years differs rather dramatically with the previous findings in that throughout all educational levels the occurrence of a tsunami in the next few years is very likely or somewhat likely (approximately 64.6%), whereas as one progresses in educational attainment from the grade school level (1-12) (8.3%) to college degree (23.3%), the response is somewhat unlikely or very unlikely. Those respondents with a grade school education were more likely to express the noncommittal category of don't know (29.2%) rather than those who hold a college degree (9.6%) (see Appendix A, Table A16).

Religious preference is associated only with the occurrence of tsunamis in the Hawaiian Islands in the next few months and years. Those survey participants who indicated that they are Protestants were more likely to express that a tsunami would occur in the Hawaiian Islands in the next few years somewhat unlikely or very unlikely (51.9%) and very likely or somewhat likely (34.3%), followed by, Buddhists somewhat unlikely or very unlikely (42.0%) and very likely or somewhat likely (34.0%), Others somewhat unlikely or very unlikely (47.0%) and very likely or somewhat likely (27.7%) and Roman Catholics somewhat unlikely or very unlikely (31.8%) and very likely or somewhat likely (43.6%) (see Appendix A, Table A16).

The Pearson Correlation Coefficient for the occurrence of a tsunami in the next few months in Hawaii was correlated with how often tsunamis occur around the world (r =.34, r^2 =.12), how well tsunamis are understood by science (r =.21, r^2 =.04), whether or not the respondent thought about tsunamis when at the beach, surfing, diving or fishing (r =.23, r^2=.06) and the amount of damage that could occur if the Hawaiian Islands were exposed to a large tsunami (r =.33, r^2 =.11) (see Appendix A, Table A16).

How often tsunamis can occur in the Hawaiian Islands within the next few years is correlated primarily with the chance of a tsunami occurring in the Hawaiian Islands within the next few months (r =.71, r^2 =.50). Other correlations ranged from r = -.12, r^2 =.01 to r =.18, r^2 =.03 and were not determined to be highly correlated with the dependent variable (see Appendix A, Table A16).

Communication Channels Employed by Survey Respondents to a Theoretical Versus an Actual Civil Defense Tsunami Warning

Theoretical. The survey participants were questioned as to their communication processes in the event of a "theoretical" tsunami. Respondents were asked to rank as first, second and third the communication route they would take to obtain Civil Defense information should a tsunami warning be sounded (see Appendix A, Table A42). Overall, if a tsunami siren should be sounded NOW, 59.9% of the respondents indicated that the first thing they would do would be to turn on the radio, 34.7% indicated that the second action they would do would be to turn on the radio. The third action the respondents said they would do is to consult the telephone directory for tsunami preparation information. If the Civil Defense department were to announce that a tsunami would impact the Hawaiian Islands in FIVE HOURS, the respondents indicated that the first thing that they would do would be to stock up on food and other necessities (28.1%), the second again stock up on food and other necessities (35.6%) and the third call relatives and friends (18.6%). If the survey participants were to hear the Civil Defense siren and be told that the a tsunami would impact the Hawaiian Islands in TEN MINUTES, the first thing the respondents indicated that they would do would be to evacuate to high ground (60.1%), the second thing would be to go to a friend's (relative's) house (29.1%) and the third, again, go to a friends (relatives) house (32.8%) (see Appendix F).

Actual. As noted previously, a mini-tsunami did impact the Hawaiian Islands. The siren was sounded on October 4, 1994 at 6:30 a.m., which was approximately five hours before the first tsunami waves were to impact the Hawaiian Islands. Of those participants who had completed the questionnaire, 80.5% indicated that they had indeed heard the Civil Defense siren, whereas 10.4% indicated that they had not heard the siren, while 3.9% were not sure. Thirty-six of the survey respondents indicated that they did "not" hear the Civil Defense (CD) siren sounding the morning of October 4, 1994. Of these individuals 18 resided in CD District 1, 3 in CD District 2, 2 in CD District 3, 2 in CD District 4, and 11 in CD District 6. Likewise, 13 respondents indicated that they were not sure as to whether or not they heard the Civil Defense (CD) siren sounding the morning of October 4, 1994. Of these participants 7 resided in CD District 1, 2 in CD District 4, and 4 in CD District 6. Overall, 75% to 100% of the survey respondents "did hear" the Civil Defense siren sounding (n = 303) (see Appendix F). Unfortunately, no statistically significant Chi Square associations were noted between survey respondent residence and tsunami risk perception variables because all of the contingency tables had some expected cell counts of less than 5.

The communication channels employed by the respondents to gain Civil Defense information was examined. Surprisingly, the results did not mimic the theoretical communication channels as noted above. When the respondents heard the first tsunami siren warning on October 4, 1994 NOW, the majority did turn on the radio (64.9%) and the television (25.8%). The telephone directory was consulted by only 2.0% of the sample participants, while 3.0% indicated that they did nothing (see Appendix A, Table

A43). Interestingly, when the respondents were notified that a tsunami would impact in FIVE HOURS, 40.5% did nothing while 20.5% contacted relatives and friends. Only 19.4% of the respondents indicated that they would stock up on food and other necessities. With only TEN MINUTES to impact, 37.1% of the survey participants indicated that they evacuated to higher ground, while 29.9% of the respondents did nothing. Only 14.5% of the respondents contacted their relatives and friends.

The Pearson Correlation Coefficients for the October 4, 1994 mini-tsunami demonstrated low correlations with the independent variables (see Appendix A, Table A16). The only correlation of note was between the communication channels for five hours and ten minutes before tsunami impact (r =.40, r^2 =.16 and r =.38, r^2 =.14, respectively).

Survey Participants' Cognitive Map of Tsunamis in Relation to 26 Natural and Technological Hazards

The survey participants were queried as to how much they know and worry about the risks from 27 natural and technological hazards. The results of this analysis would indicate where the survey respondents cognitively and emotionally place tsunamis in relation to how much they know or worry about the other 26 natural or technological hazards. All 27 natural and technological hazards were then ranked according to the participants' responses concerning their knowledge and worry about the risks posed by these hazards. This overview of how the survey participants ranked the risks from each of the 27 natural and technological hazards was followed by specific rankings according to category (i.e., natural or technological) (see Appendix A, Tables A37, A38 & A39).

Survey participant responses were measured utilizing a five point Likert Scale (i.e., nothing, a little, some, a lot and not sure) (see Appendix B, Figures B17 & B18; Appendix F). Scatterplots were constructed according to selected Likert Scale categories (i.e., know a lot with worry a lot (see Appendix B, Figures B19 & B20). The 7 natural hazards (i.e., floods, hurricanes, tsunamis, landslides, earthquakes, flash floods and volcanoes) were then separated from the overall scatterplot and were replotted for each of the selected Likert Scale combinations (see Appendix B, Figure B20).

(Note: Only the Likert scales which measure know a lot and worry a lot will be used in this dissertation).

Each of the 27 natural and technological hazards were analyzed to determine if gender, age, marital status, language spoken in the home other than English, the presence or absence of dependent children or "dependent" elderly in the household, educational attainment, total family income, length and city of residency in Hawaii, religious preference, race/ethnicity identification and religiosity or spirituality of the survey participants influenced their conception of the risks posed by these hazards (see Appendix A, Tables A17 to A36).

When the two categories of know a lot and worry a lot were ranked, a difference was noted for participant concern. In the category of participant knowledge concerning the risks from these hazards, those who indicated they know a lot ranked cigarette smoking first, drinking alcohol second, (Acquired Immune Deficiency Syndrome) AIDS third, motor vehicle accidents fourth, and crime and violence fifth. In this category tsunamis ranked seventh. However, when the participants' responses were ranked according to which of the hazards they worry a lot about, a difference in priority was noted. Respondents ranked crime and violence first, AIDS second, street drugs third, motor vehicle accidents fourth and cigarette smoking fifth. Tsunamis ranked fifteenth in this category (see Appendix A, Table A37).

Natural hazards. When the risks were ranked according to know a lot, the risks associated with hurricanes ranked first, tsunamis second, earthquakes third, floods fourth, and volcanoes fifth, and worry a lot about hurricanes ranked first, earthquakes second, tsunamis third, flash floods fourth and volcanoes fifth (see Appendix A, Table A39).

Technological hazards. When the risks associated with technological hazards were ranked according to know a lot, the risks associated with cigarette smoking ranked first, drinking alcohol second, AIDS third, motor vehicle accidents fourth and crime and violence fifth. In the worry a lot category crime and violence ranked first, AIDS second, street drugs third, motor vehicle accidents fourth and cigarette smoking fifth (see Appendix A, Table A39).

Scatterplots of the data demonstrate graphically the spatial arrangement of the 27 natural and technological hazards according to the survey participants' response to know a lot with worry a lot. The scatterplots indicate the spatial position of tsunamis in relation the other 26 natural or technological risks. In general, tsunamis fall below the 50th percentile for both know a lot and worry a lot about the risks associated with this natural hazard (see Appendix B, Figures B19 & B20).

CHAPTER 5

DISCUSSION

This chapter will focus on a discussion of the results obtained from this survey concerning (1) study design, (2) comprehension of tsunami nomenclature by survey participants, (3) the influence which the media has on survey respondents' risk perception of tsunamis, (4) the cognitive and emotional characterization of survey respondents in relation to 12 risk perception categories, (5) the sociodemographic influences on survey respondents' risk perception beliefs and attitudes concerning tsunamis, (6) the communication channels employed by survey respondents to a theoretical versus an actual Civil Defense tsunami warning, (7) the survey participants' cognitive map of tsunamis in relation to 26 natural and technological risks and (8) the public health implications of this research for public health education and Civil Defense preparedness.

Study Design

This study represented the first time a doctoral student at the University of Hawaii, School of Public Health, was able to access the jury pool of the First Circuit Court in Hawaii for public health or social science research. The demographic distribution of the jury pool used for this sample frame, while not absolutely similar to the composition of the residents of Oahu, Hawaii was rather remarkably similar to the 1990 United States Census of Oahu. The external validity of this study is possibly subject to criticism because of noted deficiencies or surpluses in each of the sociodemographic categories. The sociodemographic characterization of the survey respondents, as noted in the results of this survey, are slightly overrepresented by participants of certain racial or ethnic identification, income category and educational attainment. Nevertheless, the sociodemographic characteristics of the jury pool of the First Circuit Court in Honolulu rather remarkably mirrored the sociodemographic characteristics of the residents of Oahu. The external validity of many study designs which measure risk perception in relation to natural or technological hazards or disasters is compromised because of a restricted variability which comprise their survey respondents. Quite often, studies in risk perception utilize university students or other readily available civic organizations (i.e., League of Women Voters, other club members, scientific experts, etc.) which may present a biased characterization of risk (Babbie, 1973). However, as with all survey analyses it must be remembered that the results are only truly applicable to the population included in the sample frame and that inference to the general population must be addressed with caution (Hedrick, et. al., 1993).

Comprehension of Tsunami Nomenclature

Tsunami knowledge. The survey respondents of this sample demonstrated some confusion as to tsunami nomenclature. The word tsunami is problematic for approximately half of the survey respondents. The older, and less precise term of tidal wave, is the layman's word-of-choice for approximately 42.9% of the survey participants, whereas, only 26.1% of the respondents correctly identified this natural hazard as seismic sea waves. Only 4.1% of the respondents incorrectly linked tsunamis with air currents or indicated that they did not know what the word tsunami means. The important point to remember about this finding is that even if respondents indicated that tsunamis were tidal waves they may cognitively understand that these are not ordinary waves and that they should take extra precautions to protect their health and safety. Additional research is needed to discern if the term "tidal wave", "seismic sea wave" or "tsunami" will elicit positive adaptive behaviors.

The source of tsunamis was less problematic for the survey participants to comprehend, although only 9.5% of the respondents were able to correctly indicate that tsunamis can be caused by volcanoes, landslides and earthquakes. Overwhelmingly, earthquakes were indicated by almost 60% of the survey participants to be the source of tsunamis. This finding relates to the respondents' "theater of experience", since almost all of the destructive tsunamis which have impacted the Hawaiian Islands have been the result of seismic events of both local or distal origin. Better education in both public and private schools will help future residents understand the various mechanisms which can produce tsunamis.

The most pronounced difficulty with tsunami nomenclature concerned the location of "evacuation zones". There has been much discussion in the Civil Defense community as to what the term-of-choice should be for those areas which are to be evacuated in the event of a tsunami (P. Takamiya, Civil Defense Educator, personal communication, April 25, 1994). This research indicates that the term "tsunami evacuation zone" is highly confusing for approximately 50% of the residents of Oahu. An alternative nomenclature such as "tsunami inundation zone" should be considered with caution since approximately 46% of the survey respondents did not know, or were unsure, as to the meaning of the word "inundation". The percent of survey participants who indicated that they understood what the word "inundation" means may actually be decreased since no criterion check was used to validate their comprehension in this study. Since, approximately 50% of the survey participants had difficulty comprehending the meaning of the terms "tsunami evacuation zone" or "tsunami inundation zone" Civil Defense authorities should consider the possibility of changing the name of these areas to "tsunami danger zones". However, it should be remembered that the word "tsunami" elicited confusion for some survey respondents. Additional research is needed to help clarify and determine which combination of words differentiate between "danger" from "nondanger" zones and help promote consistent positive adaptive behavior.

How the survey respondents' received information or knowledge concerning tsunamis demonstrated the importance of the media in the dissemination of tsunami-related information. Overwhelmingly, the participants indicated that they receive their tsunami information through radio and television sources. McCombs and Shaw (1994) examined which media seem to have the most significant agenda-setting effects (i.e., radio, television or print media). The authors discovered television, with its large audience, to be the critical agenda setter when compared to radio and the print media.

Apparently, little exchange of tsunami-related information or knowledge is transferred through the channels of friends or relatives or formal school education. Approximately, 76.0% of the survey respondents indicated that not enough tsunami-related information is taught in the school system. This could indicate that not enough tsunami-related information is being transferred from the classroom and into the home. A program to teach primary school educators about tsunami-related information throughout the State of Hawaii was developed by Dr. Daniel Walker in conjunction with Mr. Paul Takamiya (D. Walker, Department of Geophysics, University of Hawaii and Mr. P. Takamiya, Oahu Civil Defense Educator, personal communications, April 25, 1994). The program was met with enthusiastic approval by those educators who attended the teaching seminars. However, it would be more beneficial in protecting the public's health if participation in these seminars was not voluntary but mandatory for all educators state-wide. This program could be expanded to include educating various civic "life-line" organizations such as the police and fire departments, emergency medical service practitioners, parks and recreation personnel, media representatives, as well as private organizations (i.e., service organizations).

Media Influence on Survey Respondents' Risk Perception of Tsunamis

Review of tsunami-related newspaper articles. A review of tsunami-related newspaper articles revealed that while these articles are becoming more numerous with increases in investigative reporting they have a tendency to rapidly diminish after a relatively short period of time (usually in weeks) following the event. Many newspaper articles were concerned with morbidity and mortality statistics after a destructive tsunami had impacted the Hawaiian Islands. Interspersed throughout these articles were stories relating personal heroism and survival. However, very few articles were devoted to exploring positive adaptive behaviors residents could take to protect their health and safety should a tsunami strike the Hawaiian Islands. However, this is not the case for low consequence or "non-event" tsunamis. These events are usually followed by articles describing the physical mechanics of tsunamis and actions people should take to protect their health and safety as well as property. Unfortunately, these articles are usually "lumped" around the natural hazard event and not evenly dispersed year-round to keep the public informed and prepared when the next tsunami will eventually impact their lives.

It is interesting to note that following the 1946 tsunami no local mythology stories related to the prediction of tsunamis were noted in any of the Hawaii newspapers. These types of articles were reported previously in both the body of the newspaper and in Letters to the Editor. It would be interesting to study why the reporting of local myths concerning the prediction of tsunamis became visibly absent in Hawaii's newspapers for subsequent tsunamis. Perhaps, this is a result of the expansion of scientific knowledge concerning tsunami mechanics with subsequent demystification of this natural hazard, or when people are killed the tolerance for mythology diminishes.

Few tsunami-related articles were "piggy-backed" on other more numerous natural hazards such as hurricanes or flash floods. Piggy-backed articles usually appear following a "non-event" natural hazard which has impacted the Hawaiian Islands or when a natural disaster has impacted another area of the nation or other countries. "Information overload" or "sensory overload" may decrease the effectiveness of tsunami-related articles if they are indeed piggy-backed too often onto hurricane-related or other natural hazard events media articles. Geophysical events generate many small and insignificant tsunamis world-wide which are not sensationally significant to warrant media exposure. Perhaps, tsunami-related articles could be related to the public when these smaller, less significant, tsunamis impact Hawaii and other portions of the world. This would serve the purpose of educating the public as to the unpredictable nature of tsunamis, as well as broaden the "theater of one's experience".

The media should be encouraged to complement Civil Defense efforts to induce positive adaptive behavior especially for low probability and high consequence events. Those who are charged with protecting the public's health should actively encourage the media to run articles on events of low occurrence even though other more sensational articles are more fiscally lucrative for these companies. Social marketing and media advocacy strategies should be employed by those people charged with protecting the public's health in encouraging the media to be more responsive to natural hazard issues (Wallack, 1990).

Cognitive and Emotional Characterization of Survey Respondents in Relation to 12 Risk Perception Categories and the Sociodemographic Influences on Survey Respondents' Risk Perception Beliefs and Attitudes Concerning Tsunamis

Voluntariness of risk. Married participants were far more likely to indicate that people did not voluntarily place themselves at risk from a tsunami when compared to those people who were single; however, single respondents were far more likely to indicate that they were undecided on this issue by almost 2:1. Perhaps those participants who are married have a personal stake in the safety of the other members of the household to be more informed as to the risks to their safety.

The presence of elderly people living in the participant's household indicated that the lifelong experiences of the senior citizen may influence the perception that people do not voluntarily place themselves at risk when compared with those households with no elderly people. Perhaps this is a "trickle down" phenomenon in comparison with the present technique of informing school age children about the risks posed by tsunamis and hoping this knowledge will "trickle-up" to the older members of the household.

Approximately 70% of the survey respondents reported that people put themselves voluntarily at risk from tsunamis. This observation and the variable of how much control over what will happen to you if you are personally impacted by a tsunami may simply reflect the nature of the hazard posed by a tsunami in relationship to technological hazards. Tsunamis usually have adequate lead times before impact in which the public can cognitively and physically prepare for its arrival as compared with other "urgent" hazards (i.e., flash floods, landslides, nuclear accidents, etc.) It would be interesting to speculate if the survey participants would indicate the same voluntariness of risk if the tsunami was of a local origin with little to no time for protection. Another possible reason why survey respondents overwhelmingly indicated that people voluntarily place themselves at risk from tsunamis is prior experience with both major and minor tsunamis. Media coverage of tsunamis which reveal curiosity seeking behavior and obvious refusal to evacuate a tsunami evacuation zone, while others evacuated tsunami danger zones in a timely manner, may further enhance the perception that people voluntarily place themselves at risk from an approaching tsunami.

Approximately one half of the survey participants indicated that they understood the difference between a local versus a tele-tsunami while the remaining half indicated that they either did not, were not sure, or didn't care about the difference between the two tsunamis. How can the regional tsunami system be differentiated from the conventional tsunami warning system? Would people who did not experience ground movement think that it was important to immediately evacuate tsunami danger zones or would they assume that they had enough time to turn on the radio and listen for instructions? These questions should be addressed in future tsunami risk perception research.

Surprisingly, 11.5% of the survey respondents indicated that they knew someone who they thought placed themselves at risk during the Oct. 4, 1994 tsunami. An inference from this percentage would indicate that approximately 90,000 people, out of 818,343 residents of Oahu, may have voluntarily placed themselves at risk during this mini-tsunami. This finding should be interpreted with caution since spurious interpretations may influence the extrapolation of how many people actually placed themselves at risk during this tsunami. Perhaps, the 11.5% of the survey respondents who indicated that they knew someone who they thought placed themselves at risk during the Oct. 4, 1994 tsunami may associate with, or know people who are sensation seekers, and are unwilling, or unable, to comply with standard evacuation requests. However, if this finding is correct then it may have grave public health implications should a truly destructive tsunami hit the Hawaiian Islands!

A review of tsunami-related newspaper articles of the 1946 tsunami indicated that people had not voluntarily placed themselves at risk during the April 1st tsunami because they had not received warning that the Territory of Hawaii would be impacted by a tsunami; however, this was not to be the case for the May 23, 1960 tsunami. For this tsunami there were a number of reports of some people not evacuating tsunami danger zones when Civil Defense sirens had been sounded. Some people had actually gone to the ocean to watch the waves approach. It should be remembered that while some people had read or had been informed that the Civil Defense tsunami warning procedures had been changed in late 1958, others had not and therefore did not or purposely decided to ignore the warning. This may be attributed to a "wait and see" attitude because of a number of tsunami false alerts following the small 1957 tsunami which struck the Hawaiian Islands (Lachman, et al. (1961). Also, many individuals located within tsunami danger zones had survived the 1946 tsunami and thought the same pattern of inundation would occur again and therefore they would be safe. This misconception was to prove costly in both lives and property.

Ease of reduction. The majority of survey respondents felt that risks from tsunamis can be somewhat or very easily reduced. The failure or breach of the tsunami breakwater in Hilo Bay following the 1946 and 1960 tsunamis prompted much discussion concerning the effectiveness of tsunami barriers. Consultants, who were called in from Japan, related their procedures and experiences with erecting physical barriers to protect coastal residents from destructive tsunamis. The Army Corps of Engineers felt that a breakwater could protect the coastal residents of Hilo but the cost of such a project was of prime importance to the residents of Hilo. Many business owners who would have lost their businesses if passive mitigative procedures were instituted were most vocal in their opposition to this plan. The business owners, quite understandably, were most concerned with obtaining a "fair-market" value for their destroyed or confiscated property. Those individuals who lost their homes during the 1946 and 1960 tsunamis were more interested in finding a suitable and safe place for their future residences. After the initial trauma of the Hilo tsunami of 1946 had subsided, the negotiations with business owners and residents demonstrated politics of non salience with the return of business as usual. However, this situation did not occur following the tsunami which struck Hilo in 1960. State and local legislators were determined to reduce the risk to the coastal residents of Hilo by enacting legislation and concomitant passive mitigative procedures (safety zones) to prevent future destruction to Hilo. It is interesting to hypothesize that the actions taken following the 1960 tsunami resulted from a transformation from an individual to a collective expansion of the "theater of one's experience" of those charged with protecting the publics' health. Certainly, it can be argued that the previous experience with the destructive 1946 tsunami, and the relative complacency of the citizenry to enact mitigative procedures following to the minor tsunamis in 1952 and 1957, instigated the decision to prevent this type of tragedy from occurring again to the city of Hilo following the destructive 1960 tsunami. Perhaps the recency of a previously perceived low probability event had created an atmosphere of "unbounded rationality" resulting in enthusiastic support by legislators and citizens alike to prevent repeat occurrences of future tsunami destruction in the city of Hilo.

Statistically significant correlations exist between how much control individuals perceive they have if they are exposed to a tsunami and whether or not death can be avoided should an individual be exposed to a tsunami. Less than one half of the survey respondents indicated that if they are exposed to a tsunami then they can probably, or definitely, control what happens to them; whereas, the remaining participants indicated that they probably cannot, definitely cannot, or are undecided as to what happens to them should they be exposed to a tsunami. Similarly, approximately 60% of the survey respondents indicated that they can probably or can definitely avoid death should they be exposed to a tsunami while the remaining respondents indicated that they probably cannot, definitely cannot or are undecided as to their ability to avoid death. These findings may reflect different locus of control personality characteristics of the survey participants. Personal risk perception and safety should be distinguished from purely physical structural considerations in how easily the risks from tsunamis can be reduced by those policy makers charged with protecting the public's health.

Newness of risk. Educational attainment and length of residency in Hawaii demonstrated statistically significant associations and correlations with how new or old the risk from tsunamis were to the survey respondents. Those with a college degree stated that their experience with tsunamis was somewhat new to very old to them whereas, those with a 12th grade or less educational attainment indicated that the their tsunami experience was very new to them. Since 40% of the survey respondents indicated that the risks from tsunamis were somewhat or very new to them this could either be a function of age or length of residency in Hawaii. However, premature conclusions as to the influence of the age of the survey participants and educational attainment in relation to tsunami experience should be considered with caution. It has been 35 years since a highly destructive tsunami has impacted the state of Hawaii and approximately two generations have been born since the last major tsunami which impacted the Hawaiian Islands. These individuals have no direct experience with a destructive tsunami. Regardless of educational level, approximately 40% of the survey respondents indicated that the risks from tsunamis were somewhat or very new to them. Havinghurst (1967) revealed that individuals who most often evacuate when told to do so in the event of a tsunami are the newest residents of a community, whereas, those residents who had previously experienced a destructive tsunami were rather indifferent or reticent in their evacuation procedures. Havinghurst (1967) also noted that the longer a person is aware of the risks that tsunamis pose to their health and safety, they will either believe the advisory and take protective behaviors, or will take a "wait and see" attitude which will have public health implications. This finding linked, with those survey participants who responded that the risks from tsunamis were somewhat or very new to them may have positive public health implications. George Pararas-Carayannis, former Director of the International Tsunami Information Center in Honolulu, noted that in the last 20 or more years, a great deal of development has taken place in the coastal areas of developing and developed nations. It would be interesting to compare the evacuation actions taken by those residents who have indicated that their tsunami experience was somewhat or very new with those who have indicated that their tsunami experience was somewhat old to very old to them and the location of residence in newly developed coastal communities.

Knowledge about risk. Survey respondents overwhelmingly linked how well the risks from tsunamis are understood to science with how well the risks are known to government. Obviously, the survey respondents feel that knowledge obtained from science concerning the risks from tsunamis is effectively related to government. Bord and O'Connor (1992) noted that trust in government is linked to trust in industry and also in a belief that the problem is amenable. Perhaps a more pronounced dichotomy concerning trust is inherent between science and government for those risks or hazards of a technological rather than natural origin. However, would this trust be eroded if scientists were to indicate that the risks from tsunamis for coastal residents were potentially catastrophic and the government failed to act on minimizing the threat to life and property? Would the credibility and trust of the policy-maker be compromised when those charged with protecting the public's health fail to achieve their goals? Perhaps, a "policy of non-action", given this scenario, would instigate a "policy of action" should a destructive tsunami actually strike the Hawaiian Islands again. This situation was indeed actualized following the tsunami which impacted the state in 1960.

The marital status of the survey participants may have influenced both the confidence that government knows about the risks from tsunamis and those who had experienced a destructive tsunami (81% of the 21% of the people who had experienced a destructive tsunami were married). Factors which influence how well scientists and the government either understand or know about the risk from tsunamis were found to be correlated with how often tsunamis occur around the world, the amount of damage produced by tsunamis, the amount of fear the survey participant has toward tsunamis and whether or not people or the government should protect themselves from tsunamis.

Exposure to risk. Most survey respondents indicated that a lot of people would be injured or killed if they were exposed to a destructive tsunami, while approximately 10% of the respondents were unable to predict such consequences. A newspaper analysis of tsunami-related newspaper articles which appeared following those destructive tsunamis which have caused extensive injury or death in the Hawaiian Islands revealed many instances of heroism or survival. While mortality and morbidity statistics were presented daily in the newspapers, there were also many articles describing rather benign experiences with the destructive tsunamis. Cognitive dissonance and lack of direct experience with a destructive tsunami may explain why some survey respondents were unable to predict the consequences to life and property. However, it is interesting to note that positive adaptive behaviors are influenced by threat producing messages (i.e., morbidity and mortality statistics) accompanied by messages of self-efficacy to evade injury and death in the event of a destructive tsunami. However, when threat producing messages are not accompanied by self-efficacy procedure the individual will reduce their cognitive dissonance by coping with the situation with denial. Perhaps the media should attempt to accompany their tsunami-related articles with information enhancing self-efficacy mechanisms which may ultimately minimize the cognitive dissonance of the population-at-risk from the deleterious effects tsunamis.

Approximately, 50% of the survey participants consider themselves to be frequently at risk from an approaching tsunami while at the beach, surfing, diving or fishing, while 20% indicated that they are never, or almost never, at risk when performing these activities with the rest indicating that they were undecided as to this issue. The length of residency in Hawaii and the age of the respondent influenced the risk perception of the survey respondents when at the beach or actively involved in the other activities. Those respondents who have resided in Hawaii for more than 18 years were evenly split as to how much risk they perceive when performing these activities. This risk perception dichotomy could be the result of past experience with tsunamis and/or their locus of control personality measures. Unfortunately, for many respondents the tsunamis of 1986 and 1994 were perceived as "non-events" and therefore may have possibly biased their risk perception of the potential destructive power of tsunamis.

Approximately 80% of the survey respondents indicated that they did not know anyone who had personally experienced a destructive tsunami. The 20% of the survey respondents who indicated that they did know someone who had experienced a destructive tsunami were more likely married, between the ages of 36 and 75 and with an income between $25,000 and $75,000. The finding that those survey respondents between the ages of 36 and 75 were 2 to 3 times more likely to know someone who had experienced a destructive tsunami is not particularly surprising considering the last destructive tsunami to impact the Hawaiian Islands was over 35 years ago. However, the 80% of those survey participants who do not know anyone who has experienced a destructive tsunami will have to rely heavily on obtaining tsunami-related information from "formal" channels (i.e., radio, television and schools). Unfortunately, vicarious experience is less effective in producing positive adaptive responses than direct experience (Bandura, 1977).

Control over risk. Locus of control personality measures for this category of risk perception indicate that the sample was evenly divided between those who have an internal, versus external, view of the world and their subsequent ability to effect change and take positive adaptive measures. Survey respondents were almost 1.5 times more likely to state that they could avoid injury should they be impacted by a tsunami than those who did not feel they could control what happens to them. Likewise, respondents were almost 2.0 times more likely to indicate that they could avoid death should they be impacted by a tsunami than those who indicated that they could not avoid death. Surprisingly, the respondents in the middle adult group (36 to 50) indicated that they definitely and probably can avoid death should they be impacted by a tsunami than either the younger (19-35) or older groups (51-75). This finding could be related to the lifestyle that these groups "traditionally" embrace. Scitovsky (1981) revealed that the tolerance for excitement varies greatly from one person to another and over time declines sharply with age. He further states that the "... greater acceptance of danger is perhaps the most important distinguishing characteristic that separates the young from the old" (p. 4). Apparently, both the young and the older groups feel particularly vulnerable to the effects of a tsunami and their ability to avoid death. This finding may be corroborated by the fact that 41.3% of the survey respondents of the young adult group (19-35) indicated that they probably cannot control what will happen to them if the are exposed to a tsunami while only 32.6% and 26.1% of the middle and older adult groups indicated as such. However, those respondents in the older adult group expressed similar risk perception with those in the young adult group in their ability to definitely and probably control what will happen to them if they are exposed to a tsunami. These findings may indicate that the young survey respondents perceived greater risk when taking part in physical activities which may place them in greater danger of injury or death from tsunamis than the older adult respondents who may live a more sedentary lifestyle and/or be physically less able to cope with extreme environmental situations. The survey respondents in the middle adult category were far more optimistic in their ability to avoid injury and death should they be impacted by a tsunami, possibly because of added responsibilities in protecting the health and safety of others and by embracing a lifestyle of diminished risks.

Survey respondent knowledge of what will happen to them if they were exposed to a tsunami influenced their perception as to whether or not they can avoid injury or death should they be impacted by a tsunami. Approximately 60% of the survey participants indicated that either injury or death would occur if they should be exposed to a tsunami. This finding, in conjunction with scientific knowledge concerning the frequency of tsunamis in Hawaii and how many people can avoid injury or death, may influence the survey respondent's risk perception concerning their ability to control what will happen to them should they be exposed to a tsunami. Surprisingly, no sociodemographic variables demonstrated statistically significant associations or correlations with control over the risk.

When the survey participants were queried as to whether or not they were personally responsible for their own safety, or if the government should protect people, the respondents indicated that they should be responsible for their own safety, but were far less decisive when the question of governmental responsibility was investigated. This finding may be the result of a low frequency of tsunamis in Hawaii coupled with a lack of experience with tsunamis which may have prevented a "learned helplessness" from influencing risk perception. This finding is reflected in the perception that most people feel they can control and/or avoid injury and death should they be impacted by a tsunami. In addition, Brun (1992) states that "Natural disasters are more often attributed to fate or random factors and this might be the reason that natural hazards are perceived as primarily a private responsibility ... Natural risks that are voluntarily undertaken and can be controlled should be personally managed, whereas for manmade risks, those risks that are controllable but involuntary should be managed and regulated by society" (p. 130). However, it would be interesting to reexamine these findings should many people be injured or killed following a highly destructive tsunami that will eventually impact the Hawaiian Islands. It would be interesting to examine how risk perception attitudes would be influenced by human intervention which may allow zoning variances and liberal construction specifications within tsunami danger zones.

The question as to whether or not people should be forcibly evacuated from their homes should a tsunami warning be issued was influenced by the length of residency and the race or ethnicity of the survey respondents. Approximately 68.0% of the participants indicated that residents should be forcibly evacuated in the event of a tsunami. Survey respondents of Asian ancestry were almost 5 times more likely to feel that people should be forcibly evacuated from their homes than the other race or ethnic groups studied in this survey. These findings could be the result of past tsunami experience, cultural differences (collectivism versus individualism) and locus of control personality measures.

Future generations. Survey respondents were relatively evenly divided between those who feel construction should be limited within tsunami danger zones and those who feel that construction should not be limited to protect the safety of future generations. Savage (1993) demonstrated that women, people of lower levels of education and income, younger people and blacks have more dread of hazards and the possible adverse effects of these hazards on future generations. While it appears that the survey participants queried in this survey confirm the findings of Savage, only the sociodemographic characteristics for educational attainment and religious preference exhibited statistical significance. It should be noted that even though other sociodemographic variables did not express statistical significance with this variable, the sample may differ in composition and risk perception attitudes from one testing period to another. Statistical significance indicates that the result in question could not occur by chance alone given a specific confidence level.

As stated previously, Pilisuk and Acredolo (1988) observed that wealthier and more educated people better understand the scientific foundations of hazards and are therefore far are more accommodating in accepting them. However, wealthier and more educated people may also have the financial means to insulate themselves from deleterious hazards. Survey respondents who are of the Buddhist and Roman Catholic faiths strongly agreed or agreed that construction should be limited in tsunami danger zones, while those of the "Other" and Protestant faiths were more likely to disagree or strongly disagree that construction should be limited in these sites to protect the safety of future generations. Additional research is needed to explore the difference between these religions as to their philosophy concerning the amount of acceptable risk they are willing to impose on future generations.

This study indicated that those survey respondents who had a 12th grade or less education were far more likely to indicate that construction should be limited in tsunami danger zones to help protect the safety of future generations. In contrast, those survey participants who have attained higher income and educational levels were less likely to indicate that construction should be limited in tsunami danger zones to help protect the safety of future generations. Many homes in Hawaii have been constructed in or near tsunami danger zones and reflect different economic values in the real estate market. It would be interesting to explore which socioeconomic group would gain or lose monetarily from limiting construction within tsunami danger zones. Flynn et al. (1994) suggest that a cost-benefit study should attempt to reflect, as accurately as possible, the following: who exactly will benefit, and to what extent? Who will bear the cost, and how much cost? Whose net positions are to be favored? Perhaps, these finding are associated with power, status, alienation and trust issues.

Issues of who is responsible for protecting the public from the deleterious effects of tsunamis (i.e., individual or government), as well as the survey respondents' locus of control personality measures, influence whether or not construction should be limited in tsunami danger zones. Further research could explore the various private and public sector ramifications of limiting construction in tsunami danger zones and of the publics' attitude if the cost burden should be shifted to their tax or insurance base.

Catastrophic potential and global catastrophe. Knowledge of the frequency of tsunamis in Hawaii and world-wide occurrence obtained through various media sources, as well as how well tsunamis are understood and known by science and the government, all influence the opinion of the survey participants as to the catastrophic effects of tsunamis. This attitude also influences the decision of whether or not people should be forcibly evacuated from their homes following a tsunami warning.

Survey respondents indicated that they perceived the frequency of tsunamis happening around the world as occurring more often than in Hawaii. This is quite interesting since many low amplitude tsunamis of local and distal origins are not reported in the media (Bill Mass, Pacific Tsunami Warning Center (PTWC), personal communication, February 23, 1993). A review of newspaper articles of the local Hawaii newspapers revealed that the frequency of articles which are concerned with world-wide tsunamis report on destructive tsunamis or the cancellation of tsunami watches following a potentially tsunamigenic seismic event. Survey respondents indicated that tsunamis occur sometimes both world-wide and in Hawaii; however, the major difference between the two predictions is that survey participants felt that tsunamis occur almost never in Hawaii. This is a reflection of survey respondents' "theater of one's experience" and the infrequency of destructive tsunamis in Hawaii. It would be interesting to see if people in Hawaii would indicate the same risk perception as to the frequency of tsunamis in Hawaii if they were exposed to a highly destructive tsunami. Would risk perception become amplified even though the frequency of tsunamis may be the same as in previous years?

Age and length of residency in the Hawaiian Islands influenced how often the survey respondents determined tsunamis occur world-wide; however, no such association was noted for occurrence specifically in the Hawaiian Islands. Older adult survey respondents were more apt to indicate that tsunamis occur world-wide more often than those of the younger age groups. This may simply be due to their added experience and knowledge base acquired over the years of their lives. It would be interesting to compare the risk perception of residents living on "neighbor islands" (i.e., Kauai, Niihau, Molokai, Lanai, Maui and Hawaii) as to the occurrence of tsunamis world-wide and locally, to the survey participants who reside on Oahu.

Changes in risk. The mini-tsunami which impacted the Hawaiian Islands on October 4, 1994 may have influenced the survey respondents risk perception as to the chances of a tsunami occurring in the Hawaiian Islands in the next few months versus years. Survey respondents predicted that the chance of a tsunami impacting the Hawaiian Islands in the next few months was less than the possibility that a tsunami would occur in the next few years. It appears that the recent October 4, 1994 mini-tsunami may have influenced the risk perception of the survey respondents as to the temporal occurrence of this natural hazard. The October 4, 1994 mini-tsunami may have activated a "gambler's fallacy" that since a tsunami had recently occurred then it would be quite a while since the next tsunami would occur. This risk perception attitude may be challenged should successive tsunamis occur close together temporally. For instance, resident compliance with Civil Defense evacuation orders were obeyed more readily when a temporally close tsunami followed the disastrous 1960 tsunami. It would be interesting to note the change in risk perception attitudes toward tsunamis with the length of time elapsed between successive tsunamis.

Educational attainment and religious preference indicated that those survey respondents who have attained a grade school education were far more likely to express that the chances of a tsunami occurring in the Hawaiian Islands would occur more frequently in the next few months than those of survey respondents with increasing educational attainment. Why do those individuals will less education feel that a tsunami would hit the Hawaiian Islands more frequently in the next few months than those with more education, given the unpredictable nature of tsunamigenic seismic events? This question warrants further research.

Dread of risk. Beck (1960) theorized that when hazards demonstrate increasing levels of probability and/or consequences, a greater level of perceived threat will occur. Approximately 40% of the survey respondents indicated that they feared tsunamis only somewhat while the rest of the survey respondents were equally divided between a great deal and very little. This finding could reflect the lack of direct experience of the survey respondents with a destructive tsunami. Apparently the presence or absence of dependent children in the survey participants' household influenced their fear of tsunamis. Those respondents who have children in their households were more likely to indicate that they feared tsunamis than those participants who do not have dependent children. Surprisingly, this study revealed that the presence or absence of elderly people living in the survey participants' household did not influence their fear of tsunamis. These findings suggests that risk perception is influenced by the concern of the survey respondents for the health and safety of dependent children, but not for elderly dependents. Savage(1993) noted that younger people have significantly higher dread of hazards than older people. This finding may possibly influence the risk perception of tsunamis of those charged with protecting the health and safety of dependent children of the survey respondents' household rather than the older members.

The level of survey respondent educational achievement indicates that those who are less educated are far more fearful of tsunamis than those who are more educated. However, as educational increases the response nearly equals out between those who fear tsunamis a great deal or somewhat with a little or not at all. Perhaps, those survey respondents who have obtained an educational attainment of 12 years or less do not receive enough tsunami information to help alleviate their fear of tsunamis. Pilisuk and Acredolo (1988) postulated that individuals who have high income levels and educational attainment were better able to understand the scientific complexities of hazards and were more accommodating to them. However, care should be taken to ascribe the level of educational attainment with fear of tsunamis solely on respondent age and experience with this natural hazard.

The religious preference of the survey respondents apparently does influence whether the survey respondent dreads tsunamis. Those respondents of Buddhist and Roman Catholic faiths indicated that they fear tsunamis a great deal or somewhat , whereas, those of the "Other" and Protestant faiths were evenly divided between a great deal or somewhat and very little or not at all. Not surprisingly, as stated previously, those survey respondents who self-identified themselves as Roman Catholics and Protestants were far more likely to indicate that they can definitely or probably control what happens to them should they be exposed to a tsunami than those who identified themselves as belonging to the "Other" category or as Buddhists. Different locus of control personalities coupled with cultural influences may influence the risk perception and personal consequences of tsunamis. The locus of control personality measures of the survey respondents who self-identified as Roman Catholic both feared and felt that they could control what happens to them should they be exposed to a tsunami; whereas, Buddhists indicated that not only do they fear tsunamis, but they also felt that they could not control what would happen to them. Interestingly, the Buddhist perspective on death or destruction from natural hazards may suggest that the consequences to a person's life was preordained by an individual's previous life (Palm, 1995). Survey participants who self-identified as Protestant or "Other" indicated that they do not fear tsunamis, but were split as to the amount of control over their destiny should they be impacted by a tsunami. These locus of control personality measures are more likely the expression of the different philosophical theologies of these various religious groups. As stated previously, Bauman and Sims (1974) compared the attitude of predominantly Roman Catholic Puerto Ricans with other United States citizens as to their views on success in the world. They noted that Puerto Ricans exhibited an external locus of control personality measure, whereas, United States citizens exhibited an internal locus of control measure. Additional research is needed on the effect of religious philosophy or theology on survey participants' risk perception of natural disasters.

The racial and/or ethnic preference of the survey respondents indicated that those of Asian, Pacific Island and "Others" ethnicity dreaded tsunamis a great deal or somewhat, whereas, Caucasians were evenly divided between a great deal or somewhat and very little or not at all. Approximately 80% of the survey respondents indicated that they have resided in Hawaii for 18 years or more which should allow some personal experience with a tsunami; however, a racial and or ethnic component to this risk perception category should be considered.

Whether or not survey respondents fear or dread tsunamis is influenced by how much is known by science, how much they think about tsunamis when at the beach or when participating in ocean related recreational activities, the safety and cost to future generations, how much damage tsunamis can do to the Hawaiian Islands and whether or not people should be forcibly evacuate from their homes once a tsunami warning had been issued. Quite notably, two of these variables exhibited moderate correlation with the dependent variable of fear of tsunamis. These variables were the cost to future generations and how much survey respondents think about tsunamis when at the beach. Locus of control personality measures and whether or not respondents export the costs and safety concerns to future generations all influence how much the respondents dread the risks posed by tsunamis to their health and safety. The public health implication of this finding is that the majority of respondents fear tsunamis either somewhat or very little. This may be an expression of an underperception of the risks which tsunamis (especially those which are locally generated) pose to their health and safety. Weinstein (1984) theorized that when risk perception is coupled with an underperception of the occurrence of an event then threat is lowered resulting in lowered risk-reducing behavior on the part of the individual. Effective threat-coping behavior may therefore be threatened by inadequate risk perception of natural and technological hazards.

Immediacy of risk. Most, but not all, survey participants who reside in evacuation zones feel they are at risk from tsunamis. Additional research is needed to explore why some people do feel they are at risk while others do not. This risk perception attitude will have important public health considerations especially if positive adaptive behaviors and timely evacuation procedures are not instituted after a tsunami warning has been issued.

Over half of the survey respondents indicated that they do not pass through tsunami danger zones on their way to and from work. Should a highly destructive tsunami occur, protecting those residents who do pass through and/or live within tsunami danger zones will be most important. The evacuation problems following the May 7, 1986 tsunami spurred the state and local officials of Hawaii to construct evacuation plans which would supposedly stagger work release of residents should a tsunami warning be given during business hours. Unfortunately, this evacuation plan has not been tested since its development in 1986 because the tsunami which struck the Hawaiian Islands in 1994 occurred during non-business hours. What about the other half of the survey respondents who indicated that they do indeed pass through tsunami danger zones to and from work? What will be the impact on these resident's health and safety if indeed they are caught in a traffic grid-lock and a destructive tsunami is actualized? Obviously this is an area of future research when the next tsunami of importance strikes the Hawaiian Islands.

More than two thirds of the survey respondents indicated that they do not personally consider themselves at risk from a tsunami, while approximately half of the participants who have resided in the Hawaiian Islands for less than 18 years do consider themselves to be at risk from tsunamis. Far more survey respondents who have lived in Hawaii for less than 18 years consider themselves to be personally at risk from a tsunami than those who have lived in Hawaii for more than 18 years. Perhaps, past experiences with low consequence tsunamis may have decreased the novelty which influences the mental availability model, or theater of one's experiences, which may negatively impact survey participants from taking positive adaptive behaviors.

The survey respondents primarily indicated that death would be the outcome should they be impacted by a tsunami, followed by injury such as being dragged out to sea, as well as other minor outcomes. Tsunami-related newspaper articles do indeed discuss mortality and morbidity statistics most commonly after a tsunami has struck the Hawaiian Islands. These statistics are then usually followed by articles which are concerned with mitigative activities to lessen the impact of future tsunamis. Interestingly, one third of the survey respondents indicated that they do not bodily fear being impacted by a tsunami, which may indicate a philosophical and/or theological belief in fate or a mechanism to reduce cognitive dissonance.

These results could reflect a threat-avoidance heuristic strategy employed by the survey respondents to minimize the psychological dissonance resulting from a low probability and potentially high consequence natural hazard. Leviton (1991) stated that people will often underperceive threat and tend to exhibit positive adaptive behaviors for relatively minor threats which are highly probable. Leviton noted that "Personal experience and availability bias teach us that accidents do not happen that much to us rather than to others. Repeated benign experiences with risk-taking activities are likely to lead to an under-perception of risk, at least on a personal basis" (p. 34). The more we have experiences which are not threatening, the more we believe we are invulnerable. The longer we go without a direct threat, the less opportunity we have to perceive our incompetencies.

As stated previously, direct personal experience with a threatening situation is far more effective in stimulating positive adaptive behaviors than when knowledge of these hazards are learned vicariously. This was strongly demonstrated two days after the devastating tsunami of May 23, 1960, when another potential tsunamigenic seismic event occurred off the Chilean coast. The response of the residents of the Hawaiian Islands to this tsunami was not as "cavalier" as the response had been two days previously. In comparison to the previous warning, the residents did not take many chances with their health and safety and promptly evacuated low-lying areas. Low-lying areas in all the Hawaiian Islands were reported to be "ghost-towns", with very few people putting themselves at risk. The signal potential of the prior destructive tsunami resulted in compliance to evacuate in a timely manner. It is interesting to conjecture what effect the experiences with the mini-tsunamis of 1986 and 1994 will have on resident compliance with evacuation orders and sensation-seeking. Obviously, this will be an area of future research.

Religiosity or spirituality. Survey respondents who indicated that their religious preference is Protestantism were far more likely to "down-play" the risks from tsunamis in comparison to the other religious groups. This finding may reflect different cultural differences or locus of control personality measures of the survey respondents expressed in the various risk perception attitudes noted in this survey. Overall, whether or not the survey participant considered themselves to be religious or spiritual had very little effect on their risk perception of tsunamis.

Communication Channels Employed by Survey Respondents to a Theoretical Versus an Actual Civil Defense Tsunami Warning

The survey participants were queried as to their tsunami information-gathering activities in relation to a theoretical and an actual tsunami. It has been many years since the last destructive tsunami impacted the Hawaiian Islands, and this may have decreased the chances that the respondent would develop a precise adaptive plan to minimize their risk should they be impacted by a tsunami. Ironically, this had also occurred following the "false-alert" of November 1960 even though a highly destructive tsunami stuck the Hawaiian Islands a few months previously. Apparently, the information presented in the media reinforced the individual's perception that another "non-event" tsunami may occur especially after additional tide stations in the tsunami warning system had indicated minimal to no wave activity. Therefore, the survey respondents did not feel threatened enough to activate their warning belief system and initiate adaptive protective behaviors that a dangerous hazard was about to impact their lives. The perception of minimal personal risk to the respondents' health and safety may account for why so many people did nothing during the October 4, 1994 mini-tsunami. A more extensive study of the information-gathering activities and communication channels employed by those populations-at-risk should be conducted immediately following the next tsunami.

It should be remembered that approximately 12% of the survey respondents indicated that they did not or were not sure they heard the Civil Defense siren the morning of the October 4th mini-tsunami. This suggests that people may not have paid close attention to the siren warning. Civil Defense authorities should actively query "predesignated residents" in tsunami vulnerable communities if they had heard the siren blast following the monthly maintenance check. An appraisal of the effectiveness of the tsunami-related information contained in the telephone directory should also be periodically examined.

The finding that most people rely on television and radio as their primary source of tsunami information is not particularly surprising since the public is requested to listen to the Emergency Broadcast System (EBS) in the event of a tsunami and to consult the telephone directory for tsunami information should the Civil Defense siren be sounded. Reliance on radio and television sources for tsunami-related information during an actual event certainly is understandable. However, this research has demonstrated that the background information concerning tsunami nomenclature and the geophysical generating forces that people rely on to be able to comprehend tsunamis may sometimes be erroneous or absent. This finding suggests that more opportunities to educate the public as to relevant tsunami information should be actively encouraged and implemented.

Cognitive Map of Tsunamis in Relation to 26 Natural and Technological Hazards

Analysis of the 27 natural and technological hazards indicate that the survey respondents ranked tsunamis as 7th in the category of knowing a lot and 15th in worrying a lot about this natural hazard. This could be the result of respondent familiarity, salience and frequency of this particular hazard in relation to the other hazards studied. The 27 hazards were then divided according to natural and technological hazards. Each hazard was then ranked according to survey respondent knowledge and worry about each hazard.

The survey participants indicated that among the 7 natural hazards evaluated in this survey, (i.e., floods, hurricanes, tsunamis, landslides, earthquakes, flash floods and volcanoes), hurricanes took precedence in both knowledge and worry followed by tsunamis. This could be a reflection as to the frequency of hurricanes during the preceding year. In 1994, numerous potentially destructive hurricanes entered Hawaiian waters. Hurricanes Iwa in 1982 and Iniki in 1992 sensitized the risk perception of the survey participants to the destructive power this natural hazard can have. It is interesting to postulate if the October 4, 1994 had turned out to be a destructive tsunami, would tsunamis supersede hurricanes in evoking the most concern? It is encouraging that the survey respondents indicated that they know a lot about tsunamis. Survey respondents ranked their knowledge of tsunamis relatively high in relation to other 26 natural or technological hazards; however, they indicated they worry a lot about tsunamis at about the 50th percentile. Perhaps, this is an indication that positive adaptive behaviors will result from a knowledgeable public. (Note: Of the technological hazards, it was not surprising to find that the survey participants are most worried about crime and violence, AIDS and street drugs and least concerned with commercial air travel, medical x-rays, video display terminals and high voltage power lines. The respondents indicated that they were uncertain as to their knowledge and worry concerning video display terminals. Not surprisingly, survey respondents were not concerned with satellites falling to earth from orbit, video display terminals, and nuclear accidents.)

Determinants of Risk and Public Health Implications

The results of this research indicate that people primarily receive their information concerning tsunamis from the media (i.e., radio, television) and relatively little information is received from friends and family. This finding indicates that the Civil Defense and local community should try as much as possible to work closely with the media to inform the public as to the risks which tsunamis can pose to their health and safety. Strategies which promote the newsworthiness of tsunami-related topics such as proactive news coverage of tsunami anniversaries, piggy-backing of tsunami articles onto other topical hazard articles, Op-ed articles, radio and television coverage and the framing of news-related stories which meet the criteria of what constitutes news should be developed by the Civil Defense community in partnership with the local community to inform and encourage proactive positive adaptive behaviors of the populace. Previously prepared media packages should be developed which could contain film footage of actual tsunamis (especially for non-event tsunamis), background information of previous tsunamis, graphic representation of the geophysical mechanisms which generate tsunamis and a list of credible and trusted scientists which the media can access in the event of a tsunami. Wallack, et al. (1993) suggests that an increased diversity of faces, voices and sources of credible information available in the newsroom will help to gain the public's attention by reducing "media burnout" which often accompanies media coverage of overly familiar topics.

Disaster preparedness programs such as the <u>Strengthening Preparedness Among Neighbors</u> (SPAN) "N'hood" program which has been instituted in Sunnyvale, CA and by the State of Washington fosters pre and post disaster involvement by the residential and business communities (Dr. LuAn Johnson, Public Educator, City of Seattle, Division of Emergency Management, Edmonds, Washington, personal communication, August 8, 1995). Perhaps, the Hawaii Speaker's Bureau can be joined with a SPAN "N'hood" program to proactively inform those populations-at-risk about the risks which tsunamis or other natural and technological disasters can present to their health and safety. Discussion within the local and Civil Defense communities should be expedited before the next destructive tsunami impacts the Hawaiian Islands.

One of the interesting findings which a review of tsunami-related newspapers revealed was the absence of Hawaiian mythologies concerned with tsunamis following the destructive tsunami which struck the Hawaiian Islands in 1946. Perhaps this occurred as a result of increased scientific knowledge concerning the generation of tsunamis. As a result of this increased knowledge, science has removed the "awesome and mysterious" nature which tsunamis once elicited in the minds of the inhabitants. Perhaps the "disinterment" of the myths which surround tsunamis could "humanize" this natural hazard and result in an enhancement of tsunami education with concomitant disaster preparedness and effective positive adaptive behaviors . Bierlein (1994) describes myth as "... the first fumbling attempt to explain how things happen, the ancestor of science. It is the first fumbling attempt to explain why things happen." Grimal (1981) states that "It is the object of the myth, as of science, to explain the world, to make its phenomena intelligible. Like science too, its purpose is to supply man with a means of influencing the Universe, of making sure of the spiritual and material possession of it. Given a Universe full of uncertainties and mysteries, the myth intervenes to introduce the human element: clouds in the sky, sunlight, storms at sea, all extra - human factors such as these lose much of their power to terrify as soon as they are given sensibility, intentions, and motivation that every individual experiences daily." The educational potential of informing the public as to the myths associated with natural and technological hazards, (i.e., tsunamis) could be an important area in need of further research.

This research clearly indicated that the comprehension of the term evacuation zone was not fully understood by more than 50% of the survey participants. Likewise, the comprehension of the alternative term, tsunami inundation zone, was also cognitively confusing for approximately 50% of the survey respondents. Therefore, Civil Defense officials should consider changing the term-of-choice from tsunami evacuation zone to tsunami danger zone. While this new term may prove to be problematic for some people, the every day usage of the word danger should prove to be less confusing than the other "scientific jargon" terms of evacuation and inundation. Hopefully, by changing the term-of-choice, which represents those areas in need of evacuation should a tsunami impact the Hawaiian Islands, will lead to less confusion and more efficient compliance from the population-at-risk to initiate positive adaptive behaviors to protect their health and safety.

One of the most controversial finding of this research is that approximately 90,000 residents of Oahu may have placed themselves voluntarily at risk during the October 4, 1994 tsunami. Of course, this finding must be interpreted with caution, since it was extrapolated from the information obtained from the 11.4% of the survey respondents who indicated that they knew someone who had put themselves at risk during the 1994 tsunami. Discounting obvious bias in the way in which this figure was obtained, it is still remarkable that so many people may have placed themselves at undue risk during this tsunami. Luckily, the tsunami had minimal to no impact, but what if the tsunami had indeed been of a destructive nature? How many people could have been killed or injured? Obviously, and unfortunately, this area will, and should be, thoroughly explored following the next tsunami which is destructive to life and property in the Hawaiian Islands.

The survey respondents overwhelmingly indicated that people place themselves voluntarily at risk from the effects of a tsunami. This finding has public health implications since the last two tsunamis in which the public had been alerted by Civil Defense authorities to evacuate low-lying areas have been termed “nonevents” (i.e., no damage to life or property). While most residents will have adequate lead time in which to take protective measures should a tsunami of distal origin impact the Hawaiian Islands this will not be the case for a locally generated tsunami. The media reported during the last two “nonevent” tsunamis that a number of people (i.e., curiosity seekers, residents who refused to evacuate houses in low-lying areas, etc.) would not evacuate after being told to do so by Civil Defense authorities. Thus, a voluntary aspect to the threat of tsunamis to life and property has been presented to the residents of Oahu by the media.

While locally generated tsunamis are of a relatively rare occurrence in the Hawaiian Islands, it should by no means be discounted as producing little to no public health impact on the residents of Oahu. A locally generated tsunami may occur with very little warning to ensure appropriate evacuation of low-lying areas. The nonvoluntary aspect of this situation accompanied by appropriate evacuation behaviors, should be related to the public in preparation for the next locally generated tsunami. One avenue for public education concerning tsunamis or other hazard preparedness could be to enhance, create and enforce tsunami information signage on Hawaii's public beaches and roadways.

Length of residency of the survey participants may have an impact on how people respond to the next destructive tsunami. Those residents who have lived in the Hawaiian Islands for over 18 years were somewhat more “cavalier” about their risk perception concerning tsunamis than were those who have been residents for less than 18 years. This attitude may be related to their past exposure to tsunamis and the impact which these events, or nonevents, had on their life and property. Ironically, those residents who are relatively new residents to the Hawaiian Islands may heed the Civil Defense warning and take protective behavior or evacuation measures than those individuals of longer residency. This research suggests that the recent “nonevent” tsunamis may have lulled people in believing that while tsunamis are of low probability, the consequences are also low in regard to their health and safety. Obviously, this hypothesis will need additional research following the next destructive tsunami to impact the Hawaiian Islands.

The survey respondents were relatively evenly divided in their attitude on limiting construction within a tsunami danger zone to reduce the costs and protect the safety of future generations. Sociodemographic variables influenced the amount of risk the survey respondents were willing to assume and “transport” to future generations. The obvious attractive nature of locating buildings near the ocean, or within low-lying coastal areas, coupled with the monetary value of properties in these areas, make legislation to reduce the amount of construction next to impossible to propose, not to mention enact. This situation did result in zoning changes following the 1960 tsunami. Residents of California who have experienced destructive earthquakes readily rebuild in the same areas knowing the risk to their life and property (Palm, 1995). Thus, the frequency of occurrence of tsunamis in Hawaii, coupled with economic risk-to-benefit influences, may hinder the limitation of construction within tsunami danger zones. Perhaps, this attitude may change should successive, and highly destructive tsunamis, occur relatively close in time to one another. Strategic plans should be developed by the state and local government agencies which will limit construction within tsunami danger zones should such a scenario become a reality.

In conclusion, the findings of this research indicate that the survey respondents do feel relatively well informed about tsunamis; however, in actuality this knowledge may be biased due to improper comprehension of tsunami generation and nomenclature. This research revealed that sociodemographic variables such as age, gender, marital status, the presence or absence of children or elderly in respondents' homes, length of residency, educational attainment, total family income, religious preference and race/ethnic identification influence risk perception.

Therefore, the results of this research answered many questions concerning the risk perception of tsunamis by a sample of the residents of Oahu. Not surprisingly, this survey generated additional questions and recommendations which should be addressed by additional future inquiry and those charged with protecting the public's health. It is important to keep in mind that the occurrence of tsunamis is a distant threat in most people's minds; whereas, common everyday problems and concerns take precedence. However, the findings of this study will offer future researchers a "baseline" in which to compare pre-and-post tsunami risk perception <u>WHEN</u> and not <u>IF</u> the next destructive tsunami strikes the Hawaiian Islands.

Recommendations and Areas of Future Research

Tsunami nomenclature. Civil Defense authorities should consider changing the current Civil Defense classification of areas in need of evacuation during a tsunami from "tsunami evacuation zone" to "tsunami danger zones". While this new term may prove to be problematic for some people, the every day usage of the word "danger" should prove to be less confusing than the other "scientific jargon" terms of "evacuation" and "inundation". Hopefully, by changing the term-of-choice it would result in less confusion and more efficient evacuation compliance from the population-at-risk to initiate positive adaptive behaviors to protect their health and safety.

Additional research concerning tsunami nomenclature should be undertaken to discern which words or terms will elicit positive adaptive behaviors (i.e., "tidal wave", "seismic sea wave", "tsunami", "danger", "nondanger").

Tsunami education. The exploratory Tsunami Education Project instituted by Dr. Daniel Walker (Institute of Geophysics) and Commander Dennis Sigrist (International Tsunami Information Center) would be more beneficial in protecting the public's health if participation in these seminars was not voluntary but mandatory for all educators (public and private) state-wide. This program could be expanded to include not only primary but middle and high school populations. Also, educating various civic "life-line" organizations such as the police and fire departments, emergency medical service practitioners, parks and recreation personnel, media representatives, as well as private organizations (i.e., service organizations) could prove beneficial in relaying the risks of tsunamis to the public. This research suggests that more opportunities to educate the public as to relevant tsunami information should be actively encouraged and implemented.

Media influence. The media should be encouraged to complement Civil Defense efforts to induce positive adaptive behavior especially for low probability and high consequence natural hazard events though social marketing and media advocacy. Media reports concerning the occurrence of tsunamis in other parts of the world could help broaden the "theater of one's experience" thereby educating the public as to the unpredictable nature of tsunamis. The media should attempt to accompany their tsunami-related, or "natural hazard-related" articles with information enhancing self-efficacy mechanisms which may ultimately minimize the cognitive dissonance of the population-at-risk from the deleterious effects of natural hazards.

Civil Defense strategies. Civil Defense authorities should actively query "predesignated residents" in tsunami vulnerable communities to confirm the siren blast during the monthly maintenance check. An appraisal of the effectiveness of the tsunami-related information contained in the telephone directory should also be periodically examined. This finding indicates that the Civil Defense and local community should try as much as possible to work closely with the media to inform the public as to the risks which tsunamis can pose to their health and safety.

Perhaps, the Hawaii Speaker's Bureau can be joined with a SPAN "N'hood" program to proactively inform those populations-at-risk about the risks which tsunamis or other natural and technological disasters can present to their health and safety. Discussion within the local and Civil Defense communities should be expedited before the next destructive tsunami impacts the Hawaiian Islands.

Civil Defense officials should relate to the public the "voluntary" or "involuntary" aspect of noncompliance with evacuation procedures and the consequences to the individual and the community. Evacuation strategies should be periodically tested and evaluated for both individual and public compliance in preparation for future local and distal tsunamis. Passive public education concerning tsunami preparedness and evacuation procedures could be obtained through increased signage on Hawaii's public beaches and roadways.

Communication channels. This research indicated that people receive their tsunami information primarily through the media followed by the community. A more extensive study of the information-gathering activities and communication channels employed by those populations-at-risk from a tsunami should be conducted immediately following the next tsunami to impact the Hawaiian Islands.

Limiting construction within tsunami danger zones. This research indicated that people of lower sociodemographic groups want construction limited within "tsunami danger zones"; whereas, the opposite is true for those in higher sociodemographic groups. Additional research is needed to discern which groups would be most impacted by setting construction limits within these "danger" areas. Nevertheless, strategic plans should be developed by the state and local government agencies which will limit construction within tsunami danger zones. Further research could explore the various private and public sector ramifications of limiting construction in tsunami danger zones and of the publics' attitude if the cost burden should be shifted to their tax or insurance base. However, it is interesting to consider that the high price of ocean-front property in Hawaii indirectly limits overdevelopment in these areas.

An additional area of research could examine how risk perception attitudes would be influenced by human intervention which may allow zoning variances and liberal construction specifications within tsunami danger zones.

Frequency of tsunamis. Research should be undertaken to see if people in Hawaii would indicate the same risk perception attitudes uncovered in this research if they were exposed to a highly destructive tsunami. It would be interesting to compare the risk perception attitudes and beliefs of residents living on "neighbor islands" (i.e., Kauai, Niihau, Molokai, Lanai, Maui and Hawaii) with Oahu residents. It would be interesting to note the temporal changes in tsunami risk perception attitudes and beliefs between successive tsunamis.

Evacuation response. Strategic plans should be drafted which will address transportation concerns preceding and following the next tsunami to hit the Hawaiian Islands. What will be the impact on these resident's health and safety if indeed they are caught in a traffic grid-lock and a destructive tsunami is actualized? Obviously this is an area of future research when the next tsunami of importance strikes the Hawaiian Islands. Additionally, it would be interesting to examine what evacuation actions residents would take who reside in newly developed coastal communities.

Sociodemographic characteristics. Research is needed to explore the philosophical difference between religions concerning not only their risk perception of natural disasters, but also the amount of acceptable risk they are willing to impose on future generations.

Future tsunamis and public health implications. This research indicated that a large number of people may have placed themselves at undue risk during the October 4, 1994 tsunami. Luckily, the tsunami had minimal to no impact, but what if the tsunami had indeed been of a destructive nature? Obviously, and unfortunately, this area will, and should be, thoroughly explored following the next destructive tsunami.

Living in a pluralistic nation presents both advantages and challenges. The distinction between "what people want" versus "should want" and public policy implementation is often fraught with constitutional implications. Interestingly, approximately 70% of the survey respondents indicated that residents-at-risk from a tsunami should be forcibly evacuated should they choose not to evacuate. This finding, alone, may indeed have profound effects on protecting the public's health!

APPENDIX A

Table A1

Population Located in Inundation Zones on Oahu, HI*

District	Population at Risk
I	8,259
II	7,058
III	18,307
IV	9,183
V	13,077
VI	4,653
Total	60,537

* Inundation zones were determined by historical run-up or by extrapolating from a 50 ft wave for north east and south Oahu and from a 30 ft wave for west Oahu.

Note. From "State of Hawaii Data Book: A Statistical Abstract", 1990, Department of Business, Economic Development and Tourism. Honolulu, HI.

Table A2

Tsunami Classification

Group	Degree	Wave height (m)	Damage
I	0	1	Construction on coast unscathed
II	1	2	Houses destroyed, small ships thrown against coast
III	2	4-6	Houses destroyed, heavy damage to husbandry
IV	3	10-20	Heavy damage along 400 km of coastline
V	4	30	Catastrophic damage along 500 km of coastline

Note. From "Medical Consequences of Natural Disasters," by L. Beinin, 1985, New York: Springer-Verlag Publishers.

Table A3

Tsunami Classification According to Type of Onset, Physical Cues, Evacuation Time and Preventive Procedures

Speed of Onset Types	Physical Cues	Evacuation Time (Approximate)	Preventive Procedures
I	Yes (?)	Less than a minute	Be very quick or dead
II	Yes	5-10 minutes	Persons who are ambulatory can be evacuated plus a few valuables
III	Yes	15-30 minutes	A few persons can be evacuated
IV	No	45 min. - 12 hours	Most persons can be evacuated and up to 75% of all movable property

Note. From "Effectiveness of tsunami warning system in selected coastal towns in Alaska" , by J. E. Haas & P. B. Trainer, 1973, Paper presented at the Fifth World Conference on Earthquake Engineering, Rome, Italy. Boulder: University of CO.]

Table A4

Tsunami Fatalities in the Hawaiian Islands from 1837 to 1993

Date	Originating Source	Impact Area & Deaths (avg.)	Maximum Height in Hawaii m	ft	Deaths (total) (min. - max.)	Damage in Hawaii (dollars)
November 7, 1837	Chile	Hawaii - Hilo (14) Maui - Kahului (2)			16 (13 - 17)	
April 2, 1868	Hawaii	Hawaii - Kau (46) - Puna (1)	45.0		46 (46 - 49)	
May 10, 1877	Chile	Hawaii - Hilo (5)			5 (5 - 5)	
February 4, 1923	Kamchatka, USSR	Hawaii - Hilo (1)			1 (1 - 1)	
April 1, 1946	Aleutian Islands, Alaska	Hawaii - Hilo (96) - Laupahoehoe (25) - Anaehoomalu (1) Maui - Hanoa (10) - Keanae (2) - Paia (1) - Mala (1) Oahu - Kahana (3) - Punaluu (1) - Kahuku (1) - Waianae (1) Kauai - Haena (7) - Wainiha (3) - Kalihikai (6) - Nawiliwili (1)	17.0	55.8	159 (141 - 173)	26,000,000
May 23, 1960	S. Chile	Hawaii - Hilo (61)	10.5	34.5	61 (61 - 62)	23,000,000
November 29, 1975	Hawaii	Hawaii - Kau (2)	14.6	47.0	2 (2 - 2)	1,500,000

Note. From "Catalog of Tsunamis in the Hawaiian Islands", by G. Pararas-Carayannis, 1969, U.S. Coast and Geodetic Survey; Loomis, H. G. (1976). The Tsunami of November 29, 1975. In: Hawaii Institute of Geophysics, University of Hawaii-Manoa, Honolulu, HI.

From "Local tsunamis in Hawaii: Implications for hazard zoning", by D. C. Cox, 1979 University of Hawaii, Hawaii Institute of Geophysics, Environ., CRT. CN: 0020, HIG-79-5.

From "Tsunami casualty and mortality in Hawaii", by D. C. Cox, 1987, University of Hawaii, Environmental Center, SR: 0040.

Table A5

A Comparison Between the Age Demographics of the City and County of Honolulu with the Sample Obtained from the First Circuit Court in Honolulu

	Age Demographics percent (%)		
Age Range (years)	State*	Sample‡	Dif†
19	1.59	0.57	-1.02
20-24	9.02	7.47	-1.55
25-29	9.59	11.78	+2.19
30-34	9.14	12.64	+3.50
35-39	8.33	10.92	+2.59
40-44	7.29	11.78	+4.49
45-49	5.56	14.94	+9.38
50-54	4.23	11.49	+7.26
55-59	4.13	4.02	-0.11
60-64	4.38	8.90	+4.52
65-69	4.06	4.59	+0.53
70-74	2.90	0.57	-2.33
75-79	1.96	0.29	-1.67
80-84	1.13	. . .	. . .
85 +	0.91	. . .	. . .

* "State of Hawaii Data Book: A Statistical Abstract", 1990, Department of Business, Economic Development and Tourism, Honolulu, HI.

‡ n = 357

† Difference between the State versus Sample demographic statistics

Table A6

A Comparison Between the Marital Status of the Residents of City and County of Honolulu with the Sample Obtained from the First Circuit Court in Honolulu

	Marital Status percent (%)		
Marital Status Distribution	State*	Sample‡	Dif†
single	30.58	32.30	+1.72
married	54.73	58.10	+3.37
divorced	7.74	7.60	-0.14
widowed	5.31	1.10	-4.21
separated	. . .	. . .	. . .

* "State of Hawaii Data Book: A Statistical Abstract", 1990, Department of Business, Economic Development and Tourism, Honolulu, HI.

‡ n = 357

† Difference between the State versus Sample demographic statistics

Table A7

A Comparison Between the Educational Attainment of the Population of the City and County of Honolulu with the Sample Obtained from the First Circuit Court in Honolulu

	Educational Distribution percent (%)		
Educational Levels	State*	Sample‡	Dif†
8th grade or less	9.38	1.40	-7.98
9th to 12th grade	37.84	18.80	-19.04
some college	20.22	21.80	+1.58
community college	8.00	17.10	+9.10
college degree	16.70	29.70	+13.00
graduate degree	7.85	11.20	+3.35

* "State of Hawaii Data Book: A Statistical Abstract", 1990, Department of Business, Economic Development and Tourism, Honolulu, HI.

‡ n = 357

† Difference between the State versus Sample demographic statistics

Table A8

A Comparison Between the Income Distribution of the Residents of the City and County of Honolulu with the Sample Obtained from the First Circuit Court in Honolulu

	Total Family Income percent (%)		
Income Distribution Categories	State*	Sample‡	Dif†
under 15,000	13.38	3.40	-9.98
15,000 to 24,999	14.51	10.10	-4.41
25,000 to 34,999	14.33	14.70	+0.37
35,000 to 49,999	18.87	19.30	+0.43
50,000 to 74,999	21.53	30.20	+8.67
75,000 to 99,999	9.49	12.10	+2.61
100,000 or more	7.89	10.30	+2.41

* "State of Hawaii Data Book: A Statistical Abstract", 1990, Department of Business, Economic Development and Tourism, Honolulu, HI.

‡ n = 357

† Difference between the State versus Sample demographic statistics

Table A9

A Comparison Between the Population Distributions of the City and County of Honolulu with the Sample Obtained from the First Circuit Court in Honolulu

	Population Distribution percent (%)		
Oahu Civil Defense Districts	State*	Sample‡	Dif†
1	47.75	46.00	-1.75
2	13.57	7.40	-6.17
3	5.37	2.30	-3.07
4	14.13	13.90	-0.23
5	1.13	0.60	-0.53
6	17.56	29.80	+12.24

* "State of Hawaii Data Book: A Statistical Abstract", 1990, Department of Business, Economic Development and Tourism, Honolulu, HI.

‡ n = 357

† Difference between the State versus Sample demographic statistics

Table A10

The Religious Distribution of the Residents of the City and County of Honolulu with the Sample Obtained from the First Circuit Court in Honolulu

	Religious Preference percent (%)
Religious Distribution	Sample‡
Atheist	1.10
Buddhist	14.20
Catholic	31.30
Mormon	1.70
Muslim	0.60
Protestant	24.80
Christian	13.40
other †	6.00
no preference or response	6.88

‡ n = 357

† The "other" category of religious preference consisted of Assembly of God (1), Buddhist-Catholic (1), Mormon-Catholic (1), Hawaiian (1), Seventh day Adventist (1), Shintoist-Buddhist (1), Spiritualist (1) and "other" (40).

Table A11

A Comparison Between the Race - Ethnicity Distributions of the City and County of Honolulu with the Sample Obtained from the First Circuit Court in Honolulu

	Race-Ethnicity Distribution percent (%)		
Race - Ethnicity	State*	Sample‡	Dif†
Black	1.80	0.60	-1.20
Chinese	6.00	8.40	+2.40
Filipino	10.60	12.60	+2.00
Hawaiian	0.50	1.70	+1.20
Part-Hawaiian •	15.70	10.60	-5.10
Japanese	21.00	33.30	+12.30
Korean	1.30	1.40	+0.10
Puerto Rican	0.20	0.80	+0.60
Samoan	0.40	0.80	+0.40
Mixed §	17.40	11.80	-5.60
White	25.00	15.70	+9.30
Other ∞	...	2.80	...

* "State of Hawaii Data Book: A Statistical Abstract", 1990, Department of Business, Economic Development and Tourism, Honolulu, HI.

‡ n = 357

† Difference between the State versus Sample demographic statistics

•The self-identified racial or ethnic heritage of the Part Hawaiian, consisted of Hawaiian-Caucasian-Chinese (3), Hawaiian-Caucasian- Chinese-Filipino (1) Hawaiian-Caucasian-Chinese-Portuguese (1), Hawaiian-Caucasian-Filipino (2), Hawaiian-Chinese (2), Hawaiian-Chinese-Filipino (1), Hawaiian-Chinese-Filipino-Puerto Rican (1), Hawaiian-Chinese-Japanese (1), Hawaiian-Chinese-Korean (1) Hawaiian-Chinese-Portuguese-Puerto Rican (1), Hawaiian-Filipino-Portuguese (1), Hawaiian-Japanese (2), Hawaiian-Portuguese (2), Hawaiian-Portuguese-Spanish (1), Part-Hawaiian [no delineation] (18).

§Those respondents who classified themselves as "mix" other than Part Hawaiian, consisted of Caucasian-Korean (1), Chinese-Filipino (5), Chinese-Filipino-Spanish (1), Chinese-Filipino-Japanese-Korean (1), Chinese-Japanese (2), Chinese-Portuguese (1), Eurasian (1), Filipino-Caucasian-Indian-Spanish (1), Filipino-Korean (1), Filipino-Portuguese (1), Filipino-Portuguese-Japanese-Puerto Rican (1), Filipino-Puerto Rican (1), Filipino-Spanish (1), Japanese-Caucasian (5), Japanese-Korean (1), Japanese-Puerto Rican (1), Portuguese-Puerto Rican (1), "mix" [no delineation] (16).

∞ The respondents who classified themselves as "other" consisted of Indian (1), Laotian (1), Vietnamese (1) and "other" [no delineation] (5).

Table A12

Response Rate of the Sample Obtained from the First Circuit Court in Honolulu (February 10-21, 1995)

	Response Category			
Sample Series	Distributed	Returned	Not Completed‡	Refused†
0-60	60	56	1	3
61-92	31	25	2	4
93-130	37	31	4	2
131-188	57	56	1	. . .
189-243	54	19	35	. . .
244-339	95	76	19	. . .
340-419	79	69	9	1
420-452	32	25	4	3
Total	445	357	75	13

‡ Insufficient time to complete questionnaire (30 minute allotment)

† ESL difficulty in completion of questionnaire

Table A13

Risk Categories, Risk Characterization & Examination and Rating Scales

Risk Category	Risk Characterization & Examination	Rating Scale
Tsunami Knowledge	Tsunamis are? (DEFTSUN)	list
	Tsunamis are caused by? (CAUSE)	list
	Where are tsunami evacuation zones? (EZONES)	list
	Do you understand the tsunami warning system? (WARN)	yes/no/don't know
	Do you understand what the words inundation and run-up means? (INUND/RUNUP)	yes/no/not sure
	Do you understand the difference between a tsunami which is produced near the Hawaiian Islands with those that come from far away countries? (LOCFAR)	yes/no/don't care
	Your knowledge of tsunamis is from? (TSUKNOW)	list
	Do you think enough information about tsunamis is given on the radio or TV by civil defense? (TSUINFO)	yes/no/don't know
	Do you think enough is taught in the schools about tsunamis? (TAUTSU)	yes/no/don't know
Voluntariness of risk	Would you agree that people are injured by tsunamis because of their own actions? (HURT)	strongly agree/ strongly disagree
	Did anyone you know put themselves in danger during the October 4, 1995 tsunami? (DANGER)	yes/no
Ease of reduction	How easily can the risks from tsunamis be reduced? (RISKREC)	very easily/never
Newness	From your experience the risks from tsunamis are? (EXPER)	very new/very old

Table A13 (Continued)

Risk Categories, Risk Characterization & Examination and Rating Scales

Risk Category	Risk Characterization & Examination	Rating Scale
Knowledge about risk	How well are the risks from tsunamis understood by scientists? (SCI)	understood/ not understood
	Are the risks from tsunamis known to the government? (GOV)	known/not known
	Have you personally experienced a destructive tsunami? (YOUPERS)	yes/no
Exposure	How many people in Hawaii can be injured by tsunamis? (INJHAW)	a few/don't know
	How many people in Hawaii can be killed by tsunamis? (KILL)	a few/don't know
	Do you know someone who has experienced a destructive tsunami? (SOMEEXP)	yes/no
	Are you personally at risk from a an approaching tsunami when you are at the beach, surfing, diving or fishing? (RISKREC)	frequently/don't know
Control over risk	If you are exposed to a tsunami can you control what happens to you? (CONTROL)	can control/cannot control
	If you are exposed to a tsunami can you avoid injury? (INJURY)	can avoid/cannot avoid
	If you are exposed to a tsunami can you avoid death? (DEATH)	can avoid/cannot avoid
	People should protect themselves from tsunamis? (PROTHEM)	agree/disagree
	The government should protect people from tsunamis? (GOVTHEM)	agree/disagree
	Should people be forced to evacuate homes located within an evacuation zone when a tsunami warning has been issued? (FOREVAC)	yes/no/don't know

Table A13 (Continued)

Risk Categories, Risk Characterization & Examination and Rating Scales

Risk Category	Risk Characterization & Examination	Rating Scale
Dread	Do you fear tsunamis? (FEAR)	a great deal/don't know
	When you are at the beach, surfing, diving or fishing do you think about the possibility of a tsunami? (SUNTHINK)	frequently/don't know
Future generations	We should protect the safety of future generations by limiting construction located within evacuation zones? (FUTURE)	agree/disagree
	We should reduce the costs to future generations by limiting construction located within evacuation zones? (COST)	agree/disagree
Catastrophic Potential	How often do tsunamis happen in Hawaii? (OFTEN)	frequently/don't know
	If the Hawaiian Islands are exposed to a large tsunami how much damage would occur? (ISLANDAM)	a lot of damage/don't know
Global catastrophe	How often do tsunamis happen around the world? (WORLD)	frequently/don't know
Immediacy of Risk	If you live, work, or travel through an evacuation zone are you at risk from a tsunami? (WORK)	yes/no/don't know
	Do your children go to school in an evacuation zone? (CHILDSCH)	yes/no/don't know
	Are you personally at risk from a tsunami? (PERS)	yes/no/don't know
	Do you know what will happen to you if you are personally hit by a tsunami wave? (HAPPEN)	yes/no/don't know

Table A13 (Continued)

Risk Categories, Risk Characterization & Examination and Rating Scales

Risk Category	Risk Characterization & Examination	Rating Scale
Religiosity	Are you a religious or spiritual person? (SPIRIT)	yes/sometimes
Changes in risk	What are the chances of a tsunami hitting the Hawaiian Islands in the next few months? (CHANCEM)	very likely/don't now
	What are the chances of a tsunami hitting the Hawaiian Islands in the next few years? (CHANCEY)	very likely/don't now
Communication process	Theoretical	
	If you were to hear the civil defense siren right now what would you do? (SRNOW)	rank
	If you heard that a tsunami was coming in 5 hours what would you do? (SRFH)	rank
	If you heard that a tsunami was going to hit the Hawaiian Islands in 10 minutes and you live in an evacuation zone what would you do? (SRTM)	rank
	Practical (After the October 4, 1994 tsunami)	
	During the October 4, 1994 tsunami did you hear the siren warning? (HEARSIR)	yes/no/not sure
	When you heard the tsunami siren warning on October 4, 1994 what did you do first? (OCNOW)	rank
	After you heard on October 4, 1994 that a tsunami was coming in 5 hours, what did you do first? (OCTFH)	rank
	When you heard that the October 4, 1994 tsunami was going to hit the Hawaiian Islands in 10 minutes, and you live in an evacuation zone, what did you do first? (OCTTM)	delineate

Table A14

Tsunami Nomenclature Identification

Tsunami Identification	Response: percent (%) n = 357
don't know	1.70
tidal waves	42.90
harbor waves	0.30
air currents	0.60
air currents & tidal waves	0.30
air currents, harbor waves & tidal waves	0.30
seismic sea waves	26.10
seismic sea waves & tidal waves	21.80
seismic sea waves & harbor waves	0.30
seismic sea waves, harbor waves & tidal waves	4.80
seismic sea waves & air currents	0.30
seismic sea waves, air currents & tidal waves	0.30
seismic sea waves, air currents, harbor waves & tidal waves	0.60

Table A15

Tsunami Causation

Tsunami Causation Categories	Response percent (%) n = 357
don't know	2.00
volcanoes	1.40
landslides	3.10
earthquakes	59.70
earthquakes & volcanoes	9.50
earthquakes & landslides	9.50
earthquakes, landslides & volcanoes	9.50
winds	2.20
winds & earthquakes	0.80
winds, earthquakes & volcanoes	0.30
winds, earthquakes & landslides	0.80
winds, earthquakes, landslides & volcanoes	1.10

Table A16

Intercorrelations Between Subscales for Tsunami Risk Perception Categories*

	Subscale	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	Pers	--	--	.14	.14	--	.11	.20	.21	.14	--	--	--	--	--	--	--	--	--
2	Hurt		--	--	.14	.18	.17	--	--	--	--	--	--	--	--	.22	.14	.18	--
3	World			--	.23	.25	.19	.16	--	--	--	--	.14	.14	.13	--	--	--	-.14
4	Happen				--	.16	.20	.15	--	.15	--	--	.18	--	--	--	--	--	-.21
5	Sci					--	.56	--	--	.16	--	--	--	--	--	.17	.14	.17	-.15
6	Gov						--	.14	.12	.22	--	--	--	--	--	.19	.21	.13	-.12
7	Home							--	.14	.22	--	--	.15	--	--	--	--	--	-.10
8	Pass								--	--	--	--	.16	--	--	.11	--	--	--
9	Beach									--	--	--	--	--	--	.13	.12	--	--
10	Away										--	--	--	--	--	--	--	--	--
11	Youpers											--	.31	--	--	--	--	--	--
12	Somexp												--	--	--	--	.11	--	-.17
13	Control													--	.70	--	.13	.22	--
14	Injury														--	--	.11	.12	--
15	Prothem															--	.68	.18	--
16	Govthem																--	--	--
17	Riskeasi																	--	-.15
18	Exper																		--

Table A16 (continued)

Intercorrelations Between Subscales for Tsunami Risk Perception Categories*

	Subscale	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
1	Pers	.12	.11	--	--	--	.12	--	--	.14	--	.13	.15	--	--	--	--	--	--
2	Hurt	.10	--	--	--	--	--	--	--	.11	--	.13	--	--	--	--	--	--	.11
3	World	--	.14	.19	--	--	.11	--	.20	.25	--	.31	.34	--	.11	--	--	--	--
4	Happen	--	.14	.13	--	--	--	--	--	.12	--	.11	.19	--	--	--	--	--	.14
5	Sci	--	--	--	--	--	.20		.12	.31	.13	.19	.21	--	--	--	--	--	--
6	Gov	.15	--	--	--	--	.17	--	--	.20	--	.16	.15	.15	--	--	--	.11	--
7	Home	.25	--	--	--	--	--	--	--	.16	--	--	--	--	.13	--	--	--	--
8	Pass	.23	--	.11	--	--	--	--	--	--	--	.15	.13	--	--	--	--	--	--
9	Beach	.26	--	--	--	--	.20	--	--	.30	--	.13	.14	--	--	--	--	--	--
10	Away	--	--	--	--	--	.14	--	.15	--	--	.12	.15	--	--	--	--	--	--
11	Youpers	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
12	Somexp	--	--	.10	-.11	--	--	--	--	.12	--	.15	.16	--	.13	--	--	--	--
13	Control	.12	-.12	.14	--	--	--	--	--	--	.39	.19	.15	--	--	--	--	--	--
14	Injury	--	.13	.19	--	--	--	--	--	--	.49	.22	.19	--	--	--	--	--	--
15	Prothem	.12	.11	--	.20	.14	.24	--	.13	.17	--	.17	.15	--	.11	--	--	--	--
16	Govthem	.11	.11	--	.29	.24	.30	--	.15	.12	--	--	--	--	--	--	--	--	--
17	Riskeasi	.14	.14	.13	--	--	--	--	--	.11	.20	--	--	--	.15	--	--	--	--
18	Exper	-.16	--	--	.12	--	--	--	--	-.14	-.18	--	.17	--	.16	--	--	--	--

Table A16 (continued)

Intercorrelations Between Subscales for Tsunami Risk Perception Categories*

	Subscale	37	38	39	40	41	42§	43	44	45	46	47	48	49	50	51	52	53
1	Pers	--	.12	--	--	--	--	--	--	--	.10	--	--	--	--	--	--	--
2	Hurt	--	--	--	--	--	.10	.12	--	--	--	--	--	--	--	--	--	--
3	World	--	--	--	--	--	--	--	--	--	--	--	--	-.13	-.13	--	--	--
4	Happen	--	--	--	--	--	--	--	--	.12	.11	--	-.18	--	--	--	--	.14
5	Sci	--	-.11		--	--	--	-.11	--	--	--	--	--	-.15	--	--	--	--
6	Gov	--	--	--	--	--	--	.13	--	--	--	--	--	-.11	--	--	--	--
7	Home	--	--	--	--	--	-.15	--	--	--	--	--	--	--	--	--	--	--
8	Pass	--	--	--	--	--	--	--	--	--	-.12	--	-.11	-.13	--	--	--	--
9	Beach	--	--	-.15	--	--	--	.11	--	--	--	.15	--	--	--	--	--	--
10	Away	--	--	--	--	--	--	--	--	--	-.14	--	--	--	--	--	--	--
11	Youpers	--	--	.14	--	--	-.10	.15	--	.12	--	1.0	--	-.11	--	--	--	--
12	Somexp	--	--	--	--	--	--	.14	--	.15	--	-.16	-.16	-.20	--	.17	--	--
13	Control	--	--	--	--	--	--	--	--	--	-.10	--	-.15	--	--	--	--	--
14	Injury	--	--	--	--	--	--	--	--	--	--	--	-.13	--	--	--	--	--
15	Prothem	--	--	--	.16	--	.12	--	--	--	--	--	--	--	--	--	--	--
16	Govthem	--	--	--	.20	--	.12	--	--	--	-.15	--	--	--	--	--	--	--
17	Riskeasi	--	--	--	.11	--	--	--	--	--	--	-.19	-.19	-.17	--	--	--	-.13
18	Exper	-.14	--	-.12	--	--	--	-.16	--	--	--	-.12	--	.14	.19	--	--	--

Table A16 (continued)

Intercorrelations Between Subscales for Tsunami Risk Perception Categories*

	Subscale	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
19	Riscrec	--	--	--	--	.11	.19	--	.13	.20	.20	--	.18	--	.11	--	--	--	--
20	Injhaw		--	.67	--	--	-.20	.10	--	--	.22	--	.18	--	.11	--	--	--	--
21	Kill			--	-.13	-.12	-.16	--	--	--	.26	.15	.14	--	--	--	--	--	--
22	Future				--	.80	.40	--	.27	--	--	.15	.10	--	--	--	--	--	--
23	Cost					--	.34	--	.23	.10	--	.16	.17	--	--	--	--	--	--
24	Fear						--	--	.44	.31	--	.16	.14	--	--	--	--	--	--
25	Spirit							--	--	.13	.12	.18	.11	--	--	--	--	.10	--
26	Sunthink								--	.23	--	.26	.23	--	--	--	--	--	--
27	Islandam									--	.18	.28	.33	--	.12	--	--	--	.14
28	Death										--	.22	.16	--	.13	--	--	--	--
29	Chancem											--	.71	--	.20	--	--	--	--
30	Chancey												--	--	.18	--	--	--	--
31	Inund													--	--	--	--	--	--
32	Locfar														--	--	--	--	--
33	Runup															--	--	--	--
34	Tsuknow																--	--	--
35	Tsuinfo																	--	--
36	Danger																		--

Table A16 (continued)

Intercorrelations Between Subscales for Tsunami Risk Perception Categories*

	Subscale	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
19	Riscrec	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
20	Injhaw		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
21	Kill	--	--	--	--	--	--	--	--	--	--	--	-.10	--	--	--	--	--
22	Future	--	--	--	--	--	.14	--	--	--	--	.17	.17	.15	--	--	.17	--
23	Cost	--	--	--	--	--	.11	--	--	--	--	--	--	--	--	--	.11	--
24	Fear	--	.17	--	.20	--	--	-.10	-.19	--	-.13	--	.16	--	--	-.12	.18	.12
25	Spirit	--	-.14	--	.15	.12	.14	--	-.12	--	--	--	--	--	--	--	--	.15
26	Sunthink	--	.20	.15	.19	--	--	--	--	--	-.13	--	--	--	--	--	.10	.11
27	Islandam	--	--	--	.22	--	.13	--	--	--	--	--	--	--	--	--	--	--
28	Death	--	--	--	--	--	--	--	--	--	--	--	-.11	--	--	--	--	--
29	Chancem	--	--	--	.14	--	--	--	--	--	-.11	--	--	--	-.11	-.10	--	--
30	Chancey	--	--	--	.15	--	--	--	--	--	--	--	--	--	-.12	--	--	--
31	Inund	--	--	--	--	--	--	-.18	--	--	--	--	-.30	-.22	--	.12	--	-.14
32	Locfar	--	--	--	--	--	--	--	--	--	--	--	--	-.13	--	--	--	-.16
33	Runup	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.10	--	--
34	Tsuknow	--	--	--	--	--	--	--	--	.16	-.16	--	--	--	--	--	--	-.15
35	Tsuinfo	--	--	--	.14	--	--	-.15	-.15	--	--	--	--	--	--	--	--	--
36	Danger	--	--	--	--	--	--	-.14	--	.11	--	--	-.11	--	-.11	--	--	-.13

Table A16 (continued)

Intercorrelations Between Subscales for Tsunami Risk Perception Categories*

	Subscale	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
37	Octnow	--	--	--	--	--	--	.13	--	--	--	--	--	-.20	--	--	--	--
38	Oct5h		--	.40	--	--	--	-.16	--	--	-.15	--	.12	--	--	--	--	--
39	Oct10m			--	--	--	-.13	--	.13	--	-.11	--	.20	--	--	--	--	--
40	Forevac				--	.11	.10	--	--	.11	-.13	--	--	--	-.11	--	--	.12
41	Tautsu					--	--	--	--	--	-.17	--	--	--	--	-.10	--	.17

* All values are significant at α = .05 level, n = 357.

§ Identification for variables: #42 = gender, #43 = age, #44 = marital status, #45 = language spoken at home, #46 = dependent children, #47 = dependent elderly, #48 = educational attainment, #49 = total family income,
#50 = length of residency, #51 = city of residence, #52 = religion, #53 = race/ethnicity.

Identification of abbreviations.

pers = personally at risk from a tsunami hurt = injured voluntarily or non voluntarily from a tsunami world = how often tsunamis happen in the world happen = do you know what will happen to you with exposure to a tsunami sci = how much are tsunamis known to science gov = how much are tsunamis known to the government home = risk at home from a tsunami pass = pass through an evacuation zone beach = risk at beach etc., from a tsunami away = risk away from beach etc. youpers = you experienced a tsunami somexp = someone you know experienced a tsunami
control = control injury or death if impacted by a tsunami injury = avoid injury from a tsunami prothem = should people protect themselves from a tsunami govthem = should the government protect people from tsunamis riskeasi = tsunami risks easily reduced exper = know anyone with tsunami experience riskrec = tsunami risk when at beach, etc.
injhaw = how many people injured in Hawaii from a tsunami kill = how many people can be killed from tsunamis
future = protect future generations from tsunamis cost = cost to future generations of tsunamis fear = fear of tsunamis
spirit = spirituality of respondent sunthink = think about tsunamis at beach, etc. islandam = Hawaii exposed to tsunami and resultant damage death = avoid death from a tsunami chancem = chance of a tsunami in months
chancey = chance of a tsunami in the years inund = understand term inundation locfar = understand difference between local and distant tsunamis runup = understand term runup tsuknow = tsunami knowledge source tsuinfo = tsunami information source danger = do you know people who have placed themselves at danger during the Oct. 4, 1995 tsunami octnow = immediate response to Oct. 4, 1995 tsunami octfh = response to Oct. 4, 1995 tsunami five hours before event octtm = response to Oct. 4, 1995 tsunami within 10 minutes of the event forevac = should people be forced to evacuate when a tsunami warning had been issued tautsu = tsunami information taught in school system.

Table A17

Knowledge About 27 Natural and Technological Risks by Gender and Age

Knowledge A LOT	Gender: Male	Gender: Female	Age Category (years): 19-35	Age Category (years): 36-50	Age Category (years): 51-75
	[percent of sample (%), n = 357]				
Cigarette Smoking	40.6	37.2	28.2	31.1	18.7
Pesticides in Food	14.7	13.6	7.0	11.0	10.1
AIDS	25.4	27.3	19.3	21.6	11.5
Drinking Alcohol	31.0	32.7	22.2	25.6	15.8
Motor Vehicle Accidents	23.3	28.4	17.4	20.6	13.4
Video Display Terminals	4.6	6.0	3.5	4.9	2.3
Tap Water	7.1	8.2	5.5	5.2	4.1
Floods	11.7	12.9	8.8	8.4	7.6
Nuclear Accidents	6.2	9.8	3.4	6.6	7.6
Satellite Falling to Earth from its Orbit	1.4	4.2	1.7	1.4	2.6
Medical x-rays	7.6	7.9	4.3	6.0	5.2
Crime and Violence	19.8	19.8	15.9	15.6	7.8
Prescription Drugs	12.1	9.6	7.5	7.8	6.0
Hurricanes	13.8	21.1	13.3	13.8	8.4
Global Warming	2.8	7.4	3.8	3.5	2.9
Street Drugs	12.1	17.5	14.1	10.4	4.9
Asteroid Hitting the Earth	0.6	2.8	1.2	0.9	1.4
Tsunamis	13.2	17.5	9.2	11.8	10.1
Landslides	5.6	5.9	4.9	3.2	3.8
Bacteria in Food	10.1	9.0	6.3	6.9	6.0
Earthquakes	11.7	13.4	8.2	10.8	6.1
Ozone Reduction in the Atmosphere	5.6	6.8	5.8	4.3	2.3
High Voltage Power Lines	5.4	11.6	7.0	6.0	4.0
Commercial Air Travel	9.3	14.1	8.6	8.4	5.8
Nuclear Waste	4.8	8.7	4.6	5.2	4.0
Flash Floods	7.1	9.9	6.9	5.8	4.3
Volcanoes	9.6	12.1	8.0	9.8	3.7

Table A18

Worry About 27 Natural and Technological Risks by Gender and Age

	Gender		Age Category (years)		
	[percent of sample (%), n = 357]				
Worry A LOT	Male	Female	19-35	36-50	51-75
Cigarette Smoking	18.8	18.0	17.2	8.9	9.8
Pesticides in Food	19.2	14.1	12.7	9.5	11.0
AIDS	21.2	23.2	18.8	14.8	10.4
Drinking Alcohol	19.4	11.3	10.7	6.0	6.3
Motor Vehicle Accidents	19.4	17.7	15.5	10.3	10.9
Video Display Terminals	4.0	4.0	4.9	2.0	0.6
Tap Water	10.8	9.7	9.9	3.8	6.7
Floods	5.6	9.0	7.1	2.3	4.0
Nuclear Accidents	8.5	13.0	11.0	4.9	5.5
Satellite Falling to Earth from its Orbit	2.5	5.1	4.6	1.4	1.1
Medical x-rays	8.7	6.2	6.9	3.2	4.0
Crime and Violence	28.2	28.5	22.2	20.2	14.4
Prescription Drugs	8.4	9.9	8.4	4.0	5.5
Hurricanes	11.8	16.0	12.1	7.8	7.8
Global Warming	6.5	8.2	7.8	2.6	4.0
Street Drugs	20.1	19.8	17.9	13.0	8.7
Asteroid Hitting the Earth	2.3	5.7	4.6	1.4	1.7
Tsunamis	7.6	11.5	8.9	4.3	5.8
Landslides	4.5	6.2	5.8	1.4	3.5
Bacteria in Food	15.0	13.3	13.0	7.2	7.8
Earthquakes	11.6	12.8	11.6	5.5	6.9
Ozone Reduction in the Atmosphere	10.4	9.0	10.1	5.5	3.5
High Voltage Power Lines	9.3	7.3	7.5	4.0	4.6
Commercial Air Travel	8.5	7.3	7.8	2.9	4.3
Nuclear Waste	10.4	12.6	10.6	4.9	7.2
Flash Floods	7.0	9.6	9.5	2.6	4.3
Volcanoes	7.0	8.4	6.2	2.6	3.7

Table A19

Knowledge About 27 Natural and Technological Risks by Marital Status

Knowledge A LOT	Marital Status [percent of sample (%), n = 357] Single	Married
Cigarette Smoking	33.8	43.9
Pesticides in Food	9.6	18.7
AIDS	23.7	29.0
Drinking Alcohol	28.4	35.2
Motor Vehicle Accidents	21.3	30.4
Video Display Terminals	5.1	5.4
Tap Water	6.8	8.5
Floods	10.3	14.3
Nuclear Accidents	5.6	10.4
Satellite Falling to Earth from its Orbit	1.7	4.0
Medical x-rays	6.5	9.0
Crime and Violence	17.3	22.4
Prescription Drugs	10.1	11.5
Hurricanes	14.6	20.3
Global Warming	4.8	5.4
Street Drugs	13.0	16.6
Asteroid Hitting the Earth	1.1	2.2
Tsunamis	10.4	20.3
Landslides	5.4	6.2
Bacteria in Food	7.0	12.1
Earthquakes	10.3	14.9
Ozone Reduction in the Atmosphere	6.2	6.2
High Voltage Power Lines	6.2	10.7
Commercial Air Travel	10.4	12.9
Nuclear Waste	5.6	7.9
Flash Floods	7.3	9.6
Volcanoes	8.7	12.9

Table A20

Worry about 27 Natural and Technological Risks by Marital Status

Worry A LOT	Marital Status [percent of sample (%), n = 357] Single	Married
Cigarette Smoking	16.0	20.8
Pesticides in Food	13.8	19.8
AIDS	20.4	24.1
Drinking Alcohol	10.1	13.5
Motor Vehicle Accidents	14.3	22.8
Video Display Terminals	4.0	4.0
Tap Water	9.4	11.1
Floods	5.9	8.7
Nuclear Accidents	9.3	12.2
Satellite Falling to Earth from its Orbit	3.6	3.9
Medical x-rays	6.5	8.4
Crime and Violence	25.7	31.1
Prescription Drugs	7.3	11.0
Hurricanes	12.6	15.2
Global Warming	8.2	6.5
Street Drugs	15.5	24.3
Asteroid Hitting the Earth	4.2	3.7
Tsunamis	7.0	12.1
Landslides	4.8	5.9
Bacteria in Food	13.6	14.7
Earthquakes	10.5	13.9
Ozone Reduction in the Atmosphere	10.1	9.3
High Voltage Power Lines	6.2	10.4
Commercial Air Travel	7.9	7.9
Nuclear Waste	11.0	12.1
Flash Floods	8.2	8.4
Volcanoes	6.7	8.7

Table A21

Knowledge About 27 Natural and Technological Risks by Dependent Children

	Dependent Children [percent of sample (%), n = 357]	
Knowledge A LOT	No	Yes
Cigarette Smoking	39.9	37.9
Pesticides in Food	13.6	14.7
AIDS	28.4	24.4
Drinking Alcohol	32.9	30.9
Motor Vehicle Accidents	27.8	24.1
Video Display Terminals	5.1	5.7
Tap Water	8.5	6.8
Floods	12.8	11.7
Nuclear Accidents	8.7	7.3
Satellite Falling to Earth from its Orbit	3.1	2.5
Medical x-rays	9.0	6.7
Crime and Violence	20.9	18.6
Prescription Drugs	12.6	9.0
Hurricanes	19.7	15.2
Global Warming	6.8	3.4
Street Drugs	15.4	14.0
Asteroid Hitting the Earth	202	1.1
Tsunamis	16.0	14.6
Landslides	6.8	4.8
Bacteria in Food	9.5	9.5
Earthquakes	13.7	11.4
Ozone Reduction in the Atmosphere	7.9	4.5
High Voltage Power Lines	8.2	8.7
Commercial Air Travel	13.2	10.1
Nuclear Waste	8.7	4.8
Flash Floods	9.9	7.0
Volcanoes	11.2	10.4

Table A22

Worry About 27 Natural and Technological Risks by Dependent Children

Worry A LOT	Dependent Children [percent of sample (%), n = 357] No	Yes
Cigarette Smoking	18.2	18.5
Pesticides in Food	16.2	16.9
AIDS	48.7	51.3
Drinking Alcohol	10.7	12.9
Motor Vehicle Accidents	17.9	19.3
Video Display Terminals	2.5	5.4
Tap Water	9.7	10.8
Floods	7.3	7.3
Nuclear Accidents	11.6	9.9
Satellite Falling to Earth from its Orbit	3.1	4.5
Medical x-rays	7.8	7.0
Crime and Violence	29.3	27.6
Prescription Drugs	9.8	8.4
Hurricanes	14.8	12.9
Global Warming	8.4	6.2
Street Drugs	16.6	23.1
Asteroid Hitting the Earth	4.5	3.4
Tsunamis	10.1	9.0
Landslides	6.2	4.5
Bacteria in Food	15.5	12.7
Earthquakes	11.3	13.0
Ozone Reduction in the Atmosphere	11.0	8.4
High Voltage Power Lines	7.7	9.5
Commercial Air Travel	8.4	7.3
Nuclear Waste	12.0	10.9
Flash Floods	9.2	7.3
Volcanoes	8.7	6.7

Table A23

Knowledge About 27 Natural and Technological Risks by Elderly Dependents

Knowledge A LOT	Elderly Dependents [percent of sample (%), n = 357] No	Yes
Cigarette Smoking	65.2	12.5
Pesticides in Food	23.1	4.6
AIDS	44.2	8.5
Drinking Alcohol	54.4	9.1
Motor Vehicle Accidents	43.4	8.0
Video Display Terminals	8.9	1.7
Tap Water	12.5	2.3
Floods	20.7	3.7
Nuclear Accidents	13.6	2.3
Satellite Falling to Earth from its Orbit	4.8	0.6
Medical x-rays	13.3	2.0
Crime and Violence	32.2	7.1
Prescription Drugs	19.2	2.3
Hurricanes	28.6	6.2
Global Warming	8.6	1.7
Street Drugs	23.8	5.4
Asteroid Hitting the Earth	2.8	0.6
Tsunamis	26.1	4.5
Landslides	9.4	2.0
Bacteria in Food	17.0	2.0
Earthquakes	21.0	3.7
Ozone Reduction in the Atmosphere	10.2	2.0
High Voltage Power Lines	13.9	2.8
Commercial Air Travel	18.1	4.2
Nuclear Waste	10.7	2.5
Flash Floods	13.6	3.1
Volcanoes	16.7	4.2

Table A24

Worry About 27 Natural and Technological Risks by Elderly Dependents

	Elderly Dependents [percent of sample (%), n = 357]	
Worry A LOT	No	Yes
Cigarette Smoking	31.4	5.4
Pesticides in Food	28.7	4.3
AIDS	37.0	7.7
Drinking Alcohol	20.4	3.1
Motor Vehicle Accidents	32.2	5.1
Video Display Terminals	6.2	1.4
Tap Water	17.1	3.1
Floods	12.2	2.6
Nuclear Accidents	16.8	4.8
Satellite Falling to Earth from its Orbit	5.9	1.7
Medical x-rays	12.7	1.7
Crime and Violence	47.2	9.7
Prescription Drugs	15.3	2.6
Hurricanes	22.6	5.1
Global Warming	13.1	1.4
Street Drugs	33.5	6.2
Asteroid Hitting the Earth	6.8	1.1
Tsunamis	15.2	3.7
Landslides	8.8	2.0
Bacteria in Food	25.6	2.3
Earthquakes	19.9	4.3
Ozone Reduction in the Atmosphere	17.0	2.3
High Voltage Power Lines	13.6	2.8
Commercial Air Travel	13.1	2.6
Nuclear Waste	19.2	4.0
Flash Floods	13.6	3.1
Volcanoes	12.4	2.8

Table A25

Knowledge About 27 Natural and Technological Risks by Educational Attainment

	Educational Attainment [percent of sample (%), n = 357]			
Knowledge A LOT	0-12 grade	Comm/ Tech	Some College	College Degree
Cigarette Smoking	14.0	12.9	16.0	34.8
Pesticides in Food	5.4	3.7	6.5	12.7
AIDS	9.0	9.8	11.5	22.5
Drinking Alcohol	11.8	10.4	13.5	28.1
Motor Vehicle Accidents	10.5	7.9	11.0	22.4
Video Display Terminals	2.3	1.4	0.6	6.5
Tap Water	4.2	1.7	3.1	6.2
Floods	6.0	3.4	4.8	10.3
Nuclear Accidents	2.5	2.5	2.2	8.7
Satellite Falling to Earth from its Orbit	0.8	1.4	0.8	2.5
Medical x-rays	2.5	2.0	3.6	7.6
Crime and Violence	7.9	5.4	9.6	16.7
Prescription Drugs	4.2	2.2	5.9	9.2
Hurricanes	5.9	6.2	7.3	15.4
Global Warming	1.1	1.7	1.4	5.9
Street Drugs	7.9	4.5	6.5	10.7
Asteroid Hitting the Earth	0.8	0.3	0.3	2.0
Tsunamis	5.6	5.1	7.3	12.6
Landslides	2.0	1.1	2.8	5.6
Bacteria in Food	3.9	2.0	4.2	9.0
Earthquakes	5.1	3.7	5.1	11.1
Ozone Reduction in the Atmosphere	0.8	2.0	3.1	6.5
High Voltage Power Lines	3.6	3.1	4.2	5.9
Commercial Air Travel	4.2	3.4	4.8	11.0
Nuclear Waste	1.7	2.0	2.8	7.0
Flash Floods	2.2	3.4	3.7	7.6
Volcanoes	4.2	3.4	4.5	9.5

Table A26

Worry About 27 Natural and Technological Risks by Educational Attainment

Worry A LOT	Educational Attainment [percent of sample (%), n = 357]			
	0-12 grade	Comm/ Tech	Some College	College Degree
Cigarette Smoking	9.2	6.7	8.4	12.3
Pesticides in Food	9.0	5.4	7.6	11.6
AIDS	11.6	8.8	10.2	14.1
Drinking Alcohol	7.3	5.1	5.6	5.6
Motor Vehicle Accidents	10.4	7.3	7.6	12.0
Video Display Terminals	3.1	1.4	1.1	2.3
Tap Water	5.4	3.7	4.0	7.4
Floods	5.6	3.1	3.1	2.8
Nuclear Accidents	6.8	4.8	4.5	5.4
Satellite Falling to Earth from its Orbit	2.8	2.0	1.1	1.7
Medical x-rays	4.2	2.5	3.1	5.0
Crime and Violence	11.8	9.6	13.8	21.7
Prescription Drugs	5.1	3.7	3.9	5.6
Hurricanes	7.6	5.3	7.0	7.8
Global Warming	5.4	2.2	3.1	3.9
Street Drugs	9.9	7.0	9.9	13.0
Asteroid Hitting the Earth	3.1	2.0	1.1	1.7
Tsunamis	5.0	4.5	5.0	4.5
Landslides	3.6	2.2	2.0	2.8
Bacteria in Food	7.0	5.1	6.5	9.6
Earthquakes	6.8	4.0	6.5	7.1
Ozone Reduction in the Atmosphere	5.1	2.5	5.1	6.7
High Voltage Power Lines	5.3	2.5	3.6	5.0
Commercial Air Travel	5.0	2.8	3.1	4.8
Nuclear Waste	7.0	4.8	4.2	7.0
Flash Floods	4.8	3.6	4.8	3.4
Volcanoes	6.4	2.8	3.1	3.1

Table A27

Knowledge About 27 Natural and Technological Risks by Total Family Income

Knowledge A LOT	Total Family Income in 1,000 Dollars ($) [percent of sample (%), n = 357]		
	less than 25	25 to 74	75 to 100 or greater
Cigarette Smoking	9.8	49.3	19.6
Pesticides in Food	3.2	17.7	7.8
AIDS	6.3	32.6	13.8
Drinking Alcohol	3.4	38.6	17.0
Motor Vehicle Accidents	5.5	32.3	14.5
Video Display Terminals	1.4	6.1	3.2
Tap Water	2.9	7.8	4.4
Floods	4.4	13.7	7.0
Nuclear Accidents	1.7	9.2	5.2
Satellite Falling to Earth from its Orbit	0.0	3.2	2.6
Medical x-rays	2.3	8.6	4.6
Crime and Violence	5.8	23.8	10.4
Prescription Drugs	4.0	12.1	5.2
Hurricanes	5.5	20.1	10.1
Global Warming	1.7	4.4	4.4
Street Drugs	5.5	17.9	6.6
Asteroid Hitting the Earth	0.0	2.0	1.4
Tsunamis	3.8	19.3	8.4
Landslides	1.7	5.2	4.9
Bacteria in Food	2.0	11.8	5.2
Earthquakes	2.6	14.9	7.9
Ozone Reduction in the Atmosphere	1.2	6.6	4.9
High Voltage Power Lines	2.3	9.5	5.5
Commercial Air Travel	2.9	13.5	7.2
Nuclear Waste	1.7	7.8	4.0
Flash Floods	3.2	3.1	6.1
Volcanoes	2.6	13.2	6.0

Table A28

Worry About 27 Natural and Technological Risks by Total Family Income

Worry A LOT	Total Family Income in 1,000 Dollars ($) [percent of sample (%), n = 357] less than 25	25 to 74	75 to 100 or greater
Cigarette Smoking	6.6	21.8	7.5
Pesticides in Food	4.9	22.0	6.9
AIDS	8.1	29.0	7.2
Drinking Alcohol	4.6	15.0	4.0
Motor Vehicle Accidents	6.6	23.0	6.9
Video Display Terminals	1.4	4.4	2.0
Tap Water	2.3	15.1	3.2
Floods	2.6	9.8	2.6
Nuclear Accidents	3.5	14.4	3.2
Satellite Falling to Earth from its Orbit	0.9	5.8	0.9
Medical x-rays	2.6	8.9	3.2
Crime and Violence	8.4	35.0	13.3
Prescription Drugs	3.2	11.2	4.0
Hurricanes	5.2	17.5	5.5
Global Warming	2.0	10.4	2.3
Street Drugs	5.8	26.5	7.8
Asteroid Hitting the Earth	0.6	6.7	0.9
Tsunamis	2.6	14.4	2.6
Landslides	1.7	6.9	2.3
Bacteria in Food	4.98	17.6	6.0
Earthquakes	4.6	15.9	4.1
Ozone Reduction in the Atmosphere	3.5	12.1	3.8
High Voltage Power Lines	2.3	11.8	2.6
Commercial Air Travel	4.0	8.9	2.9
Nuclear Waste	4.9	14.9	3.4
Flash Floods	4.3	9.8	2.9
Volcanoes	2.6	10.9	2.0

Table A29

Knowledge About 27 Natural and Technological Risks by Year Residing in Hawaii

	Residing in Hawaii (years) [percent of sample (%), n = 357]	
Knowledge A LOT	less than 18	greater than 18
Cigarette Smoking	15.4	62.4
Pesticides in Food	7.9	20.3
AIDS	12.6	40.2
Drinking Alcohol	12.6	51.1
Motor Vehicle Accidents	11.0	40.8
Video Display Terminals	3.1	7.6
Tap Water	3.4	11.9
Floods	6.3	18.2
Nuclear Accidents	4.2	11.8
Satellite Falling to Earth from its Orbit	1.4	4.2
Medical x-rays	5.3	10.4
Crime and Violence	9.3	30.2
Prescription Drugs	5.3	16.2
Hurricanes	8.4	26.4
Global Warming	1.7	8.5
Street Drugs	6.2	23.3
Asteroid Hitting the Earth	1.1	2.2
Tsunamis	5.9	24.7
Landslides	3.9	7.6
Bacteria in Food	5.3	13.7
Earthquakes	7.7	17.4
Ozone Reduction in the Atmosphere	3.1	9.3
High Voltage Power Lines	5.6	11.2
Commercial Air Travel	6.7	16.6
Nuclear Waste	3.4	10.1
Flash Floods	3.7	13.2
Volcanoes	3.1	18.5

Table A30

Worry About 27 Natural and Technological Risks by Years Residing in Hawaii

Worry A LOT	Residing in Hawaii (years) [percent of sample (%), n = 357] less than 18	greater than 18
Cigarette Smoking	7.3	29.4
Pesticides in Food	6.5	27.0
AIDS	9.0	35.6
Drinking Alcohol	4.5	19.1
Motor Vehicle Accidents	6.2	31.1
Video Display Terminals	2.3	5.6
Tap Water	4.8	15.6
Floods	3.1	11.5
Nuclear Accidents	3.9	17.5
Satellite Falling to Earth from its Orbit	1.4	6.2
Medical x-rays	2.8	12.0
Crime and Violence	11.3	45.6
Prescription Drugs	3.9	14.3
Hurricanes	6.7	21.0
Global Warming	3.7	11.0
Street Drugs	7.6	32.1
Asteroid Hitting the Earth	1.7	6.2
Tsunamis	4.5	14.6
Landslides	3.1	7.6
Bacteria in Food	5.4	22.8
Earthquakes	6.2	18.1
Ozone Reduction in the Atmosphere	5.1	14.3
High Voltage Power Lines	3.9	12.6
Commercial Air Travel	2.5	13.2
Nuclear Waste	4.8	18.2
Flash Floods	3.6	12.9
Volcanoes	4.2	11.2

Table A31

Knowledge About 27 Natural and Technological Risks by Civil Defense District

Knowledge A LOT	Civil Defense District [percent of sample (%), n = 357]					
	D1	D2	D3	D4	D5	D6
Cigarette Smoking	33.9	5.7	2.3	11.7	0.6	23.4
Pesticides in Food	12.6	2.9	1.2	2.9	0.0	8.9
AIDS	23.6	4.3	2.0	8.0	0.6	14.2
Drinking Alcohol	28.8	5.1	1.7	11.1	0.6	16.5
Motor Vehicle Accidents	24.1	3.7	1.2	8.0	0.3	14.4
Video Display Terminals	4.6	2.0	0.6	0.9	0.0	2.6
Tap Water	6.0	2.3	1.2	2.0	0.0	3.4
Floods	10.4	2.3	1.4	2.9	0.0	7.2
Nuclear Accidents	7.4	1.7	0.8	1.4	0.0	4.6
Satellite Falling to Earth from its Orbit	2.0	0.9	0.3	0.9	0.0	1.7
Medical x-rays	7.7	2.0	0.8	0.8	0.3	4.0
Crime and Violence	19.8	2.0	2.0	6.0	0.3	9.5
Prescription Drugs	9.7	2.0	1.1	2.6	0.6	5.4
Hurricanes	16.2	3.1	1.4	4.3	0.3	9.4
Global Warming	4.9	1.2	0.6	0.9	0.0	2.6
Street Drugs	11.1	2.6	1.7	4.3	0.3	9.4
Asteroid Hitting the Earth	1.4	0.6	0.3	0.3	0.0	0.8
Tsunamis	14.8	2.0	1.4	4.3	0.3	8.0
Landslides	5.1	1.1	1.1	0.9	0.0	3.1
Bacteria in Food	8.8	2.0	1.1	1.7	0.3	4.8
Earthquakes	11.3	1.4	0.9	4.0	0.3	6.9
Ozone Reduction in the Atmosphere	4.6	1.4	0.6	1.4	0.0	4.3
High Voltage Power Lines	8.0	1.4	0.8	2.0	0.0	4.6
Commercial Air Travel	13.4	1.4	1.1	2.3	0.3	4.3
Nuclear Waste	6.0	1.1	1.1	1.1	0.0	4.0
Flash Floods	6.9	1.4	1.1	2.9	0.3	4.0
Volcanoes	9.9	1.1	1.4	2.8	0.3	6.0

Districts. D1 Honolulu; D2 Waialae; D3 Maili; D4 Kailua; D5 Kahuku; D6 Pearl City

Table A32

Worry About 27 Natural and Technological Risks by Civil Defense District

Worry A LOT	Civil Defense District [percent of sample (%), n = 357]					
	D1	D2	D3	D4	D5	D6
Cigarette Smoking	14.5	2.8	0.8	5.7	0.0	12.8
Pesticides in Food	12.6	2.3	0.9	5.4	0.3	12.0
AIDS	18.3	3.4	1.2	6.9	0.0	14.9
Drinking Alcohol	8.6	1.7	0.8	3.4	0.0	9.1
Motor Vehicle Accidents	14.2	3.1	0.8	4.8	0.0	13.9
Video Display Terminals	1.4	1.2	0.6	1.2	0.0	3.2
Tap Water	7.2	1.7	0.6	3.5	0.0	7.2
Floods	4.8	0.6	0.6	2.8	0.0	5.7
Nuclear Accidents	8.3	0.6	1.1	3.4	0.0	8.0
Satellite Falling to Earth from its Orbit	2.8	0.3	0.6	1.1	0.0	2.8
Medical x-rays	6.8	1.7	0.8	0.8	0.0	4.3
Crime and Violence	25.7	3.7	1.1	7.4	0.0	19.1
Prescription Drugs	6.6	1.4	0.6	3.1	0.0	6.6
Hurricanes	11.1	1.7	0.8	4.6	0.0	9.4
Global Warming	5.7	0.6	0.9	3.1	0.0	4.3
Street Drugs	15.4	2.6	1.1	6.0	0.3	14.3
Asteroid Hitting the Earth	2.3	0.0	0.6	1.4	0.0	3.7
Tsunamis	7.1	1.1	1.1	2.8	0.0	6.8
Landslides	3.7	1.1	0.8	1.7	0.0	3.4
Bacteria in Food	11.7	1.7	1.1	4.3	0.3	8.9
Earthquakes	8.0	2.3	0.9	4.3	0.0	8.3
Ozone Reduction in the Atmosphere	6.6	1.1	0.8	4.0	0.0	6.3
High Voltage Power Lines	6.2	0.8	0.6	2.6	0.0	5.7
Commercial Air Travel	5.7	1.1	1.1	1.7	0.0	5.7
Nuclear Waste	8.5	0.8	0.8	4.3	0.0	8.3
Flash Floods	6.0	0.6	1.1	2.8	0.0	5.7
Volcanoes	5.4	0.8	1.1	2.8	0.0	4.8

Districts. D1 Honolulu; D2 Waialae; D3 Maili; D4 Kailua; D5 Kahuku; D6 Pearl City

Table A33

Knowledge About 27 Natural and Technological Risks by Religious Preference

Knowledge A LOT	Religious Preference [percent of sample (%), n = 357] Other	Buddhist	Catholic	Protestant
Cigarette Smoking	19.4	9.1	24.9	24.6
Pesticides in Food	4.3	3.7	12.1	7.8
AIDS	11.7	7.1	18.9	14.9
Drinking Alcohol	16.6	6.9	20.6	19.4
Motor Vehicle Accidents	11.5	6.3	18.7	15.0
Video Display Terminals	2.9	0.3	5.5	2.0
Tap Water	3.2	1.2	7.5	3.4
Floods	5.8	3.2	10.1	5.5
Nuclear Accidents	4.0	2.0	5.4	4.6
Satellite Falling to Earth from its Orbit	2.0	0.3	2.3	0.9
Medical x-rays	2.3	2.3	6.6	4.6
Crime and Violence	7.8	4.0	14.1	14.8
Prescription Drugs	4.3	2.6	7.4	7.4
Hurricanes	7.7	4.6	10.6	12.0
Global Warming	1.7	1.4	4.3	2.9
Street Drugs	5.7	2.9	12.0	8.6
Asteroid Hitting the Earth	1.1	0.3	1.1	0.9
Tsunamis	7.4	4.6	9.7	9.1
Landslides	2.6	2.0	4.0	2.9
Bacteria in Food	4.3	2.3	8.0	4.6
Earthquakes	5.2	4.4	9.0	6.7
Ozone Reduction in the Atmosphere	2.9	1.7	4.0	3.7
High Voltage Power Lines	3.1	1.4	7.7	4.6
Commercial Air Travel	5.1	1.7	10.0	6.6
Nuclear Waste	2.8	2.0	5.1	3.7
Flash Floods	4.3	2.3	5.4	4.9
Volcanoes	4.8	2.6	7.7	6.6

Table A34

Worry About 27 Natural and Technological Risks by Religious Preference

	Religious Preference [percent of sample (%), n = 357]			
Worry A LOT	Other	Buddhist	Catholic	Protestant
Cigarette Smoking	7.1	6.0	13.1	10.0
Pesticides in Food	7.5	4.0	12.3	9.2
AIDS	9.2	6.3	16.1	12.1
Drinking Alcohol	4.0	2.9	9.7	6.9
Motor Vehicle Accidents	8.6	6.0	14.0	8.3
Video Display Terminals	1.2	0.6	4.6	1.4
Tap Water	5.8	1.7	7.2	5.5
Floods	2.9	2.3	6.9	2.6
Nuclear Accidents	5.2	2.0	9.5	5.2
Satellite Falling to Earth from its Orbit	1.7	0.3	4.0	1.7
Medical x-rays	2.6	1.7	6.3	4.0
Crime and Violence	12.0	7.2	18.9	18.3
Prescription Drugs	2.0	2.6	7.4	5.7
Hurricanes	5.7	4.3	10.0	7.7
Global Warming	3.4	0.9	5.4	4.9
Street Drugs	10.9	3.7	14.3	10.3
Asteroid Hitting the Earth	1.4	0.3	4.0	2.3
Tsunamis	3.7	3.1	8.3	3.7
Landslides	2.0	1.4	4.9	2.3
Bacteria in Food	7.4	3.2	9.7	7.4
Earthquakes	4.9	3.2	10.6	5.5
Ozone Reduction in the Atmosphere	5.4	1.7	6.3	6.0
High Voltage Power Lines	2.8	2.3	7.1	4.3
Commercial Air Travel	3.7	1.7	7.2	3.2
Nuclear Waste	5.4	2.3	8.6	6.6
Flash Floods	2.3	2.6	7.4	4.0
Volcanoes	2.6	1.1	8.0	3.7

Table A35

Knowledge About 27 Natural and Technological Risks by Race - Ethnicity

Knowledge A LOT	Race - Ethnicity [percent of sample (%), n = 357] Other	Asian	Pacific Islander	White
Cigarette Smoking	11.5	40.2	11.2	14.9
Pesticides in Food	3.4	14.4	4.0	6.5
AIDS	9.0	24.7	7.3	11.8
Drinking Alcohol	11.0	31.2	8.4	13.2
Motor Vehicle Accidents	8.8	26.1	5.7	11.3
Video Display Terminals	2.6	4.5	1.4	2.3
Tap Water	2.5	6.2	2.5	4.0
Floods	3.7	12.2	2.8	5.7
Nuclear Accidents	2.0	7.3	2.0	4.8
Satellite Falling to Earth from its Orbit	0.8	2.8	0.8	1.1
Medical x-rays	1.7	7.6	2.2	4.2
Crime and Violence	5.1	20.1	7.1	7.3
Prescription Drugs	2.2	10.9	3.1	5.3
Hurricanes	5.3	16.3	3.4	9.8
Global Warming	2.0	5.9	0.6	1.7
Street Drugs	5.1	14.0	6.2	4.2
Asteroid Hitting the Earth	0.0	2.0	0.8	0.6
Tsunamis	3.9	16.0	4.8	5.9
Landslides	1.4	5.1	2.2	2.8
Bacteria in Food	1.4	9.5	3.1	5.0
Earthquakes	2.8	13.4	2.8	6.0
Ozone Reduction in the Atmosphere	2.0	5.9	1.4	3.1
High Voltage Power Lines	2.8	6.5	3.4	4.2
Commercial Air Travel	2.8	10.1	3.6	6.7
Nuclear Waste	2.2	6.2	1.7	3.4
Flash Floods	2.0	7.3	3.1	4.5
Volcanoes	3.1	10.1	4.5	3.9

Table A36

Worry About 27 Natural and Technological Risks by Race - Ethnicity

Worry A LOT	Other	Asian	Pacific Islander	White
	Race - Ethnicity [percent of sample (%), n = 357]			
Cigarette Smoking	5.9	22.1	4.5	4.2
Pesticides in Food	6.5	17.5	5.6	3.9
AIDS	8.5	23.7	7.1	5.4
Drinking Alcohol	4.2	13.2	3.6	2.5
Motor Vehicle Accidents	5.3	22.7	5.9	3.4
Video Display Terminals	1.4	3.7	2.0	0.8
Tap Water	4.0	9.7	4.6	2.3
Floods	2.5	8.4	2.8	0.8
Nuclear Accidents	4.2	10.4	4.5	2.2
Satellite Falling to Earth from its Orbit	1.4	3.6	2.2	0.3
Medical x-rays	2.5	9.0	2.2	1.1
Crime and Violence	7.3	33.0	8.2	8.4
Prescription Drugs	2.5	9.8	3.6	2.2
Hurricanes	3.9	15.1	3.9	4.8
Global Warming	3.4	6.2	3.4	1.7
Street Drugs	6.5	22.2	6.8	4.2
Asteroid Hitting the Earth	1.4	4.0	2.0	0.6
Tsunamis	3.4	10.9	3.6	1.1
Landslides	2.0	4.8	2.8	1.1
Bacteria in Food	5.6	14.1	4.5	3.9
Earthquakes	3.9	13.0	4.8	2.5
Ozone Reduction in the Atmosphere	3.1	9.0	4.2	3.1
High Voltage Power Lines	2.2	9.0	3.6	1.7
Commercial Air Travel	2.5	8.7	3.1	1.4
Nuclear Waste	3.6	11.5	4.8	3.1
Flash Floods	3.1	9.0	3.6	0.8
Volcanoes	3.1	7.6	3.9	0.8

Table A37

General Ranking of Knowledge and Worry about 27 Natural and Technological Risks

	Ranking (n = 357)									
Risk Category	K* n'ing	W† n'ing	K a little	W a little	K some	W some	K a lot	W a lot	K not sure	W not sure
Cigarette Smoking	25	11	27	26	25	21	1	5	24	14
Pesticides in Food	15	25	18	28	10	6	9	6	15	21
AIDS	22	24	25	25	15	23	3	2	20	11
Drinking Alcohol	26	15	26	17	18	7	2	10	20	24
Motor Vehicle Accidents	24	26	24	24	17	2	4	4	24	24
Video Display Terminals	3	3	8	11	22	23	24	25	1	2
Tap Water	11	14	13	3	9	21	20	13	6	24
Floods	17	10	17	6	7	16	11	22	11	14
Nuclear Accidents	4	6	6	10	24	24	18	12	2	5
Satellite Falling to Earth from its Orbit	1	2	7	20	27	25	26	27	2	3
Medical x-rays	8	16	2	2	20	12	19	21	6	21
Crime and Violence	21	26	23	27	8	11	5	1	20	14
Prescription Drugs	18	17	15	11	5	7	13	16	12	14
Hurricanes	23	22	21	21	6	1	6	8	12	27
Global Warming	6	9	10	6	15	17	25	22	5	6
Street Drugs	13	20	20	23	12	18	8	3	27	11
Asteroid Hitting the Earth	2	1	9	22	26	26	27	25	4	1
Tsunamis	27	22	22	9	1	3	7	15	20	21
Landslides	10	5	5	6	14	19	23	24	15	7
Bacteria in Food	14	21	12	19	11	4	15	7	15	14
Earthquakes	20	19	16	16	3	5	10	9	24	14
Ozone Reduction in the Atmosphere	7	13	1	11	19	14	22	14	6	4
High Voltage Power Lines	9	8	4	4	21	22	16	17	10	7
Commercial Air Travel	12	18	14	1	13	10	12	19	12	15
Nuclear Waste	5	7	2	15	23	22	21	11	6	10
Flash Floods	18	12	11	4	4	15	16	17	15	7
Volcanoes	16	4	19	14	2	20	14	20	19	11

K* = Knowledge (n'ing = nothing)

W† = Worry (n'ing = nothing)

Table A38

General Ranking by Category of Knowledge and Worry about 27 Natural and Technological Risks

	Ranking (n = 357)									
Risk Category	K* n'ing	W† n'ing	K a little	W a little	K some	W some	K a lot	W a lot	K not sure	W not sure
Natural Risks										
Floods	17	10	17	6	7	16	11	22	11	14
Hurricanes	23	22	21	21	6	1	6	8	12	27
Asteroid Hitting the Earth	2	1	9	22	26	26	27	25	4	1
Tsunamis	27	22	22	9	1	3	7	15	20	21
Landslides	10	5	5	6	14	19	23	24	15	7
Earthquakes	20	19	16	16	3	5	10	9	24	14
Flash Floods	18	12	11	4	4	15	16	17	15	7
Volcanoes	16	4	19	14	2	20	14	20	19	11
Technological Risks										
Cigarette Smoking	25	11	27	26	25	21	1	5	24	14
Pesticides in Food	15	25	18	28	10	6	9	6	15	21
AIDS	22	24	25	25	15	23	3	2	20	11
Drinking Alcohol	26	15	26	17	18	7	2	10	20	24
Motor Vehicle Accidents	24	26	24	24	17	2	4	4	24	24
Video Display Terminals	3	3	8	11	22	23	24	25	1	2
Tap Water	11	14	13	3	9	21	20	13	6	24
Nuclear Accidents	4	6	6	10	24	24	18	12	2	5
Satellite Falling to Earth from its Orbit	1	2	7	20	27	25	26	27	2	3
Medical x-rays	8	16	2	2	20	12	19	21	6	21
Crime and Violence	21	26	23	27	8	11	5	1	20	14
Prescription Drugs	18	17	15	11	5	7	13	16	12	14
Global Warming	6	9	10	6	15	17	25	22	5	6
Street Drugs	13	20	20	23	12	18	8	3	27	11
Bacteria in Food	14	21	12	19	11	4	15	7	15	14
Ozone Reduction in the Atmosphere	7	13	1	11	19	14	22	14	6	4
High Voltage Power Lines	9	8	4	4	21	22	16	17	10	7
Commercial Air Travel	12	18	14	1	13	10	12	19	12	15
Nuclear Waste	5	7	2	15	23	22	21	11	6	10

K* = Knowledge (n'ing = nothing)

W† = Worry (n'ing = nothing)

Table A39

Specific Ranking by Category of Knowledge and Worry about 27 Natural and Technological Risks

	Ranking (n = 357)									
Risk Category	K* n'ing	W† n'ing	K a little	W a little	K some	W some	K a lot	W a lot	K not sure	W not sure
Natural Risks										
Floods	4	4	5	2	6	5	4	6	2	5
Hurricanes	7	7	7	7	5	1	1	1	3	8
Asteroid Hitting the Earth	1	1	2	8	8	8	8	8	1	1
Tsunamis	8	7	8	4	1	2	2	3	7	7
Landslides	2	3	1	2	7	6	7	7	4	2
Earthquakes	6	6	4	6	3	3	3	2	8	5
Flash Floods	5	5	3	1	4	4	6	4	4	2
Volcanoes	3	2	6	5	2	7	5	5	6	4
Technological Risks										
Cigarette Smoking	18	7	19	17	16	12	1	5	17	10
Pesticides in Food	13	17	13	18	4	3	7	6	12	15
AIDS	16	16	15	16	8	16	3	2	14	8
Drinking Alcohol	19	10	18	11	10	4	2	8	14	16
Motor Vehicle Accidents	17	18	16	15	9	1	4	4	13	16
Video Display Terminals	3	2	7	7	13	16	17	18	1	1
Tap Water	9	9	1	3	3	12	14	11	5	16
Nuclear Accidents	2	3	5	6	15	18	12	10	2	4
Satellite Falling to Earth from its Orbit	1	1	6	13	17	19	19	19	2	2
Medical x-rays	7	11	2	2	11	8	13	16	5	16
Crime and Violence	15	18	15	27	2	7	5	1	14	10
Prescription Drugs	14	12	12	7	1	4	9	13	10	10
Global Warming	5	6	8	5	8	10	18	17	4	5
Street Drugs	11	14	14	14	6	11	6	3	19	8
Bacteria in Food	12	15	9	12	5	5	10	7	12	10
Ozone Reduction in the Atmosphere	6	8	1	7	10	9	16	12	5	3
High Voltage Power Lines	8	5	4	4	12	14	11	14	9	6
Commercial Air Travel	10	13	11	1	7	10	8	15	10	14
Nuclear Waste	4	4	2	10	14	14	15	9	5	7

K* = Knowledge (n'ing - nothing)

W† = Worry (n'ing - nothing)

Table A40

Newspaper Analysis for Tsunami Related Articles in the Honolulu Advertiser and Star Bulletin (1929-1994)

YEAR	TSUNAMI GENERATED INFORMATION (SPECIFIC)	TSUNAMI INFORMATION (GENERAL)	HUMAN INTEREST	TSUNAMI WARNINGS AND SYSTEMS	LEGISLATIVE	STATISTICS
1929	0	2	0	0	0	0
1930	1	0	0	0	0	0
1931	0	0	0	0	0	0
1932	1	0	0	0	0	0
1933	0	1	0	0	0	0
1934	1	0	0	0	0	0
1935	0	0	0	0	0	0
1936	0	0	0	0	0	0
1937	0	0	0	0	0	0
1938	2	0	0	0	0	0
1939	0	0	0	0	0	0
1940	0	0	0	0	0	0
1941	0	0	0	0	0	0
1942	0	0	0	0	0	0
1943	0	0	0	0	0	0
1944	0	0	0	0	0	0
1945	0	0	0	0	0	0
1946	14	15	21	8	11	40
1947	1	1	2	6	0	1
1948	2	0	0	3	0	0
1949	0	0	1	1	0	0
1950	0	2	1	0	0	0
1951	0	0	0	0	0	0
1952	14	2	0	4	0	6
1953	3	4	1	2	0	2
1954	0	0	0	0	0	0
1955	1	0	0	0	0	0
1956	0	1	2	0	0	1
1957	2	9	3	13	0	5
1958	4	5	0	5	0	1
1959	1	2	0	0	0	1
1960	9	16	5	19	0	9
1961	0	5	2	0	0	2
1962	1	5	1	2	0	0
1963	4	11	0	2	0	0
1964	3	3	2	1	0	0
1965	2	24	1	12	0	1
1966	2	12	1	7	0	0
1967	1	3	0	7	0	0
1968	0	1	0	9	0	0
1969	0	11	0	9	2	0
1970	0	5	0	6	1	0
1971	1	1	0	4	5	0
1972	0	2	1	2	1	0
1973	0	0	1	2	0	0
1974	3	0	1	2	0	0
1975	2	9	7	5	1	8
1976	0	3	1	2	1	0
1977	0	1	0	1	5	0
1978	0	0	1	1	0	0
1979	0	4	1	2	0	0
1980	0	1	0	1	0	0

Table A40 (Continued)

Newspaper Analysis for Tsunami Related Articles in the Honolulu Advertiser and Star Bulletin (1929-1994)

YEAR	TSUNAMI GENERATED INFORMATION (SPECIFIC)	TSUNAMI INFORMATION (GENERAL)	HUMAN INTEREST	TSUNAMI WARNINGS AND SYSTEMS	LEGISLATIVE	STATISTICS
1981	0	2	0	1	0	0
1982	1	1	0	0	0	1
1983	0	2	0	0	0	0
1984	0	4	2	2	0	0
1985	1	0	0	2	0	0
1986	6	6	11	8	0	0
1987	0	0	2	1	0	0
1988	0	1	1	1	1	0
1989	1	5	1	1	0	0
1990	0	0	0	0	0	0
1991	0	0	0	0	0	0
1992	2	2	2	3	3	0
1993	2	2	1	0	1	0
1994	10	21	12	5	0	0
1995	...	...	...	...	...	...
Total	96	207	88	162	32	78
Percent	14.5	31.2	13.3	24.4	4.8	11.8

Table A41

Tsunami Knowledge Sources

Tsunami Knowledge Categories	Response percent (%), n = 357
friends & family	3.90
television & radio	52.80
television & friends & family	2.20
own experience	8.70
own experience & friends & family	0.60
own experience & television & radio	2.80
own experience, television & radio & friends & family	1.40
school	12.60
school & friends & family	0.30
school & television & radio	7.90
school, television/radio, friends & family	2.80
school & own experience	1.10
school, own experience & television & radio	0.60
school, own experience, television/radio, friends & family	2.20

Table A42

The Ranking of Emergency Preparation Activities Following a Civil Defense Siren Warning for Three Theoretical Temporal Periods

	Theoretical Siren Warning Interval percent (%), n = 357		
Emergency Preparation Activity	Siren Warning NOW rank 1	Siren Warning NOW rank 2	Siren Warning NOW rank 3
turn on the television	23.00	33.90	9.80
turn on the radio	59.90	34.70	1.80
call family and friends	1.70	12.40	28.90
call civil defense	0.60	1.20	3.10
evacuate immediately	7.00	2.90	20.90
consult telephone directory	5.60	13.60	29.80
do nothing	2.20	1.20	5.80
	Siren Warning FIVE HOURS TO IMPACT rank 1	Siren Warning FIVE HOURS TO IMPACT rank 2	Siren Warning FIVE HOURS TO IMPACT rank 3
call family and friends	20.80	14.60	18.60
return to house	11.20	16.60	7.60
stock up on food and other necessities	28.10	35.60	11.40
evacuate to high ground	9.30	8.10	13.30
go to civil defense shelter	5.60	6.10	14.80
go to a friend's house	5.90	8.10	18.10
not worry	18.50	10.90	13.80
stay home	0.60	. . .	2.40
	Siren Warning TEN MINUTES TO IMPACT rank 1	Siren Warning TEN MINUTES TO IMPACT rank 2	Siren Warning TEN MINUTES TO IMPACT rank 3
call family and friends	15.60	18.50	19.30
go to the ocean	. . .	0.40	0.50
return to house	4.50	4.40	7.30
evacuate to high ground	60.10	22.00	9.90
go to civil defense shelter	13.60	25.60	29.70
go to a friend's house	5.10	29.10	32.80
stay home	1.10	. . .	0.50

Table A43

The Ranking of Emergency Preparation Activities Following the Civil Defense Siren Warning for the October 4, 1994 Tsunami for Three Actual Temporal Periods

Emergency Preparation Activity	Actual Siren Warning Interval percent (%), n = 357
	Siren Warning NOW rank
turn on the television	25.80
turn on the radio	64.90
call family and friends	2.00
call civil defense	0.60
evacuate immediately	1.40
consult telephone directory	2.00
do nothing	3.20
	Siren Warning FIVE HOURS TO IMPACT rank
call family and friends	22.50
return to house	4.30
stock up on food and other necessities	19.40
evacuate to high ground	7.10
go to civil defense shelter	0.60
go to a friend's house	2.60
not worry	40.50
stay home	3.10
	Siren Warning TEN MINUTES TO IMPACT rank
call family and friends	14.50
go to the ocean	0.60
return to house	2.90
evacuate to high ground	37.10
go to civil defense shelter	6.70
go to a friend's house	4.10
stay home	4.30
do nothing	29.90

APPENDIX B

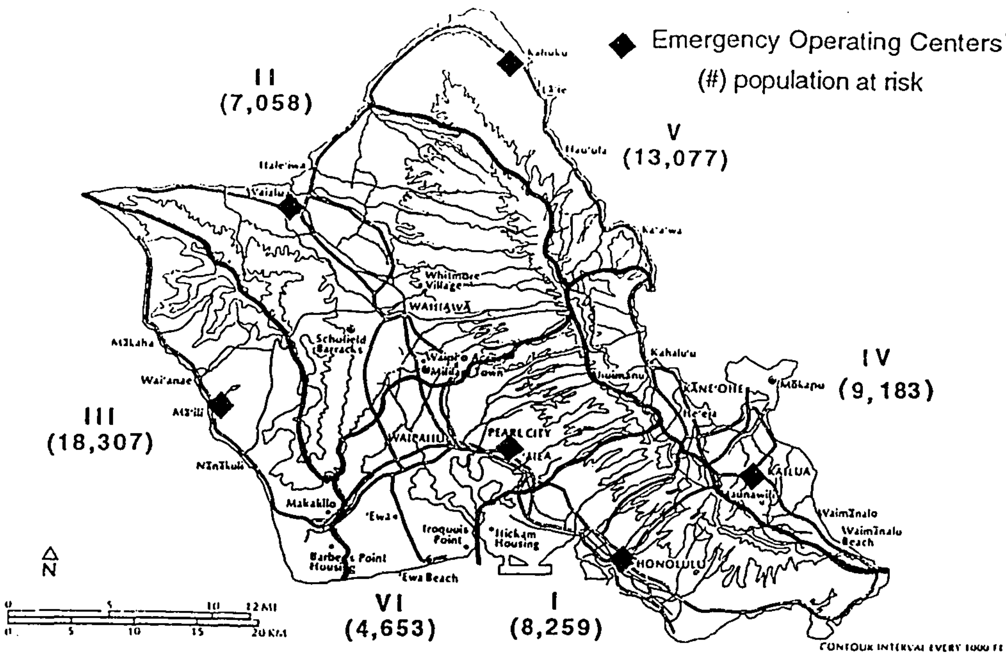


Figure B1. Population-at-risk located near or within tsunami inundation zones on Oahu, Hawaii.

Note. Oahu Civil Defense Districts

Source. Curtis, G. D. (1991). Hawaii tsunami inundation/ evacuation map project. Hawaii State Civil Defense Agency, Joint Institute for Marine and Atmospheric Research (JIMAR) Contribution No. 91-237.

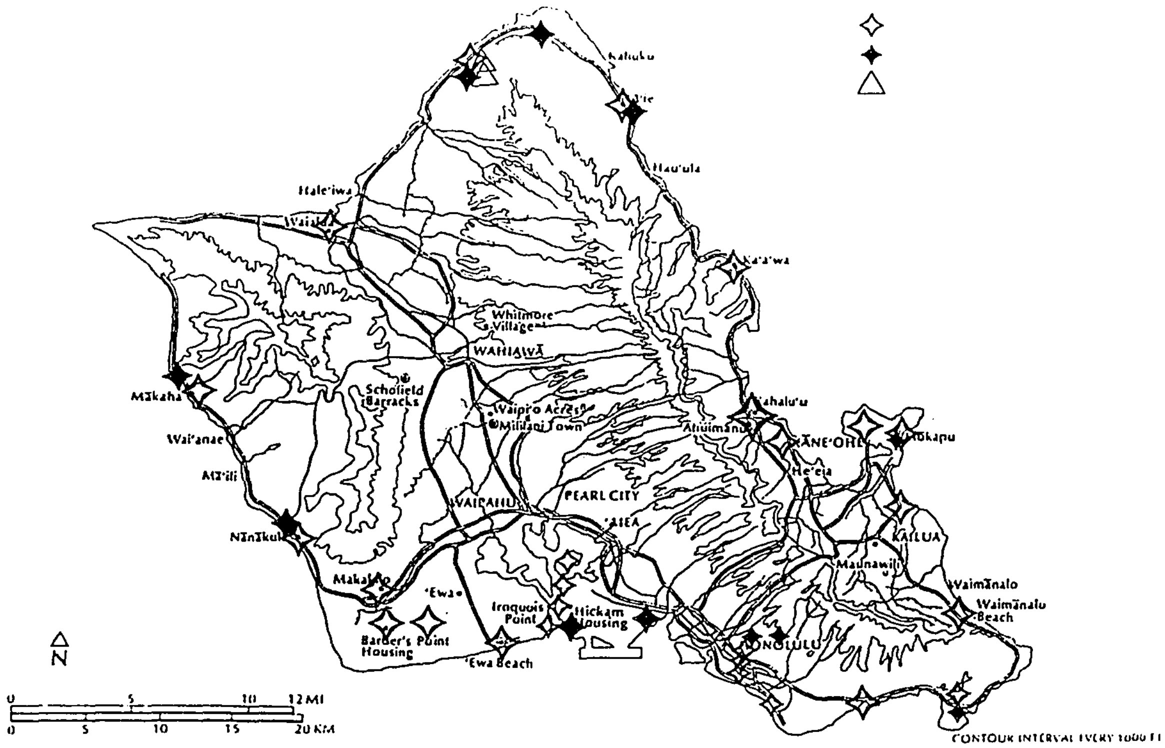


Figure B2. GTE Hawaiian Tel central offices, cable stations, satellite station and radio stations located near or within tsunami inundation zones on Oahu, Hawaii. Source. Oahu Civil Defense.

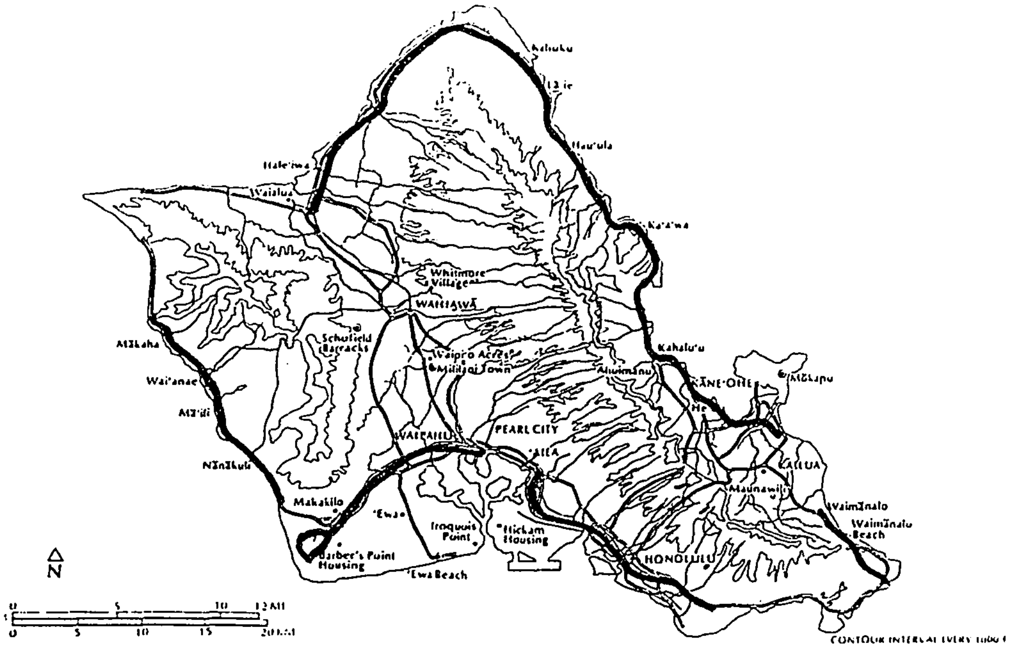


Figure B3. Hawaiian Electric Company (HECO) overhead electric lines (46 kv) located near or within tsunami inundation zones on Oahu, Hawaii.

Source. Oahu Civil Defense.

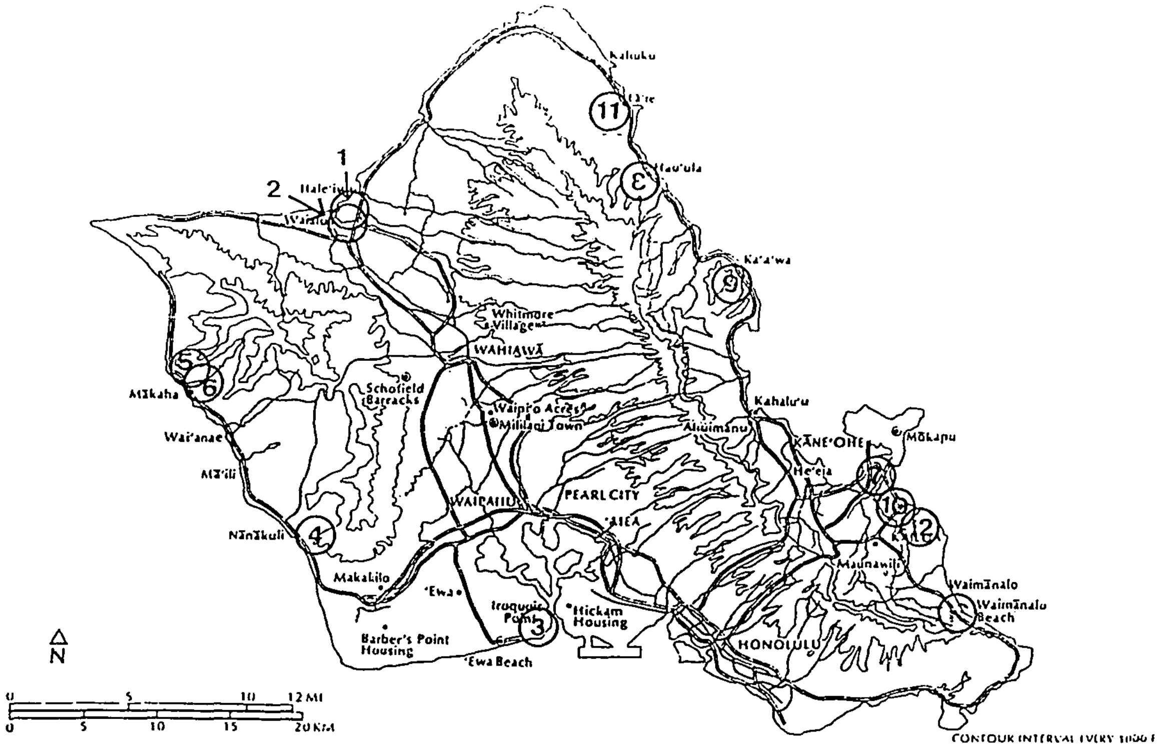


Figure B4. Public schools located near or within tsunami inundation zones on Oahu, Hawaii.

Note. (1) Haleiwa Elementary
(2) Waialua Elementary
(3) Iroquois Point Elementary
(4) Nanaikapono Elementary
(5) Waianae High
(6) Waianae Intermediate (to 2nd floor)
(7) Aikahi Elementary
(8) Hauula Elementary
(9) Kaaawa Elementary
(10) Kainalu Elementary
(11) Laie Elementary
(12) Lanikai Elementary
(13) Pope Elementary

Source. Oahu Civil Defense.

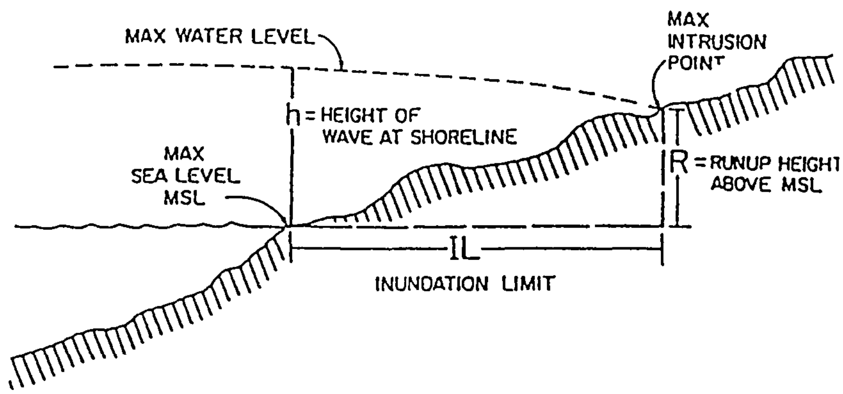
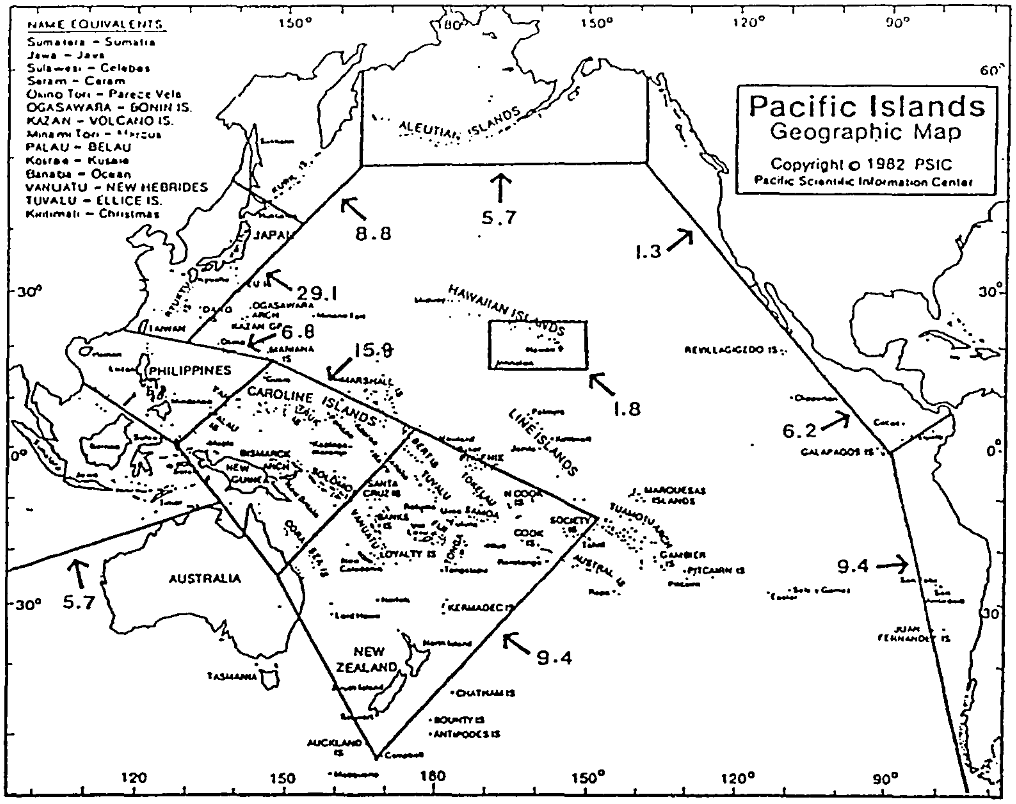


Figure B5. Definition sketch of tsunami terms.

Source. Curtis, G. D. (1991). Hawaii tsunami inundation/ evacuation map project. Hawaii State Civil Defense Agency, Joint Institute for Marine and Atmospheric Research (JIMAR) Contribution No. 91-237.



<u>Figure B6.</u> Tsunamigenic earthquake activity. Regional tsunami activities in the Pacific Ocean expressed in percent (%).

<u>Source.</u> Iida, K. (1983) In: K. Iida & T. Iwasaki (Eds.), <u>Tsunamis – Their science and engineering.</u> Tokyo: Terra Scientific Publishing Company.

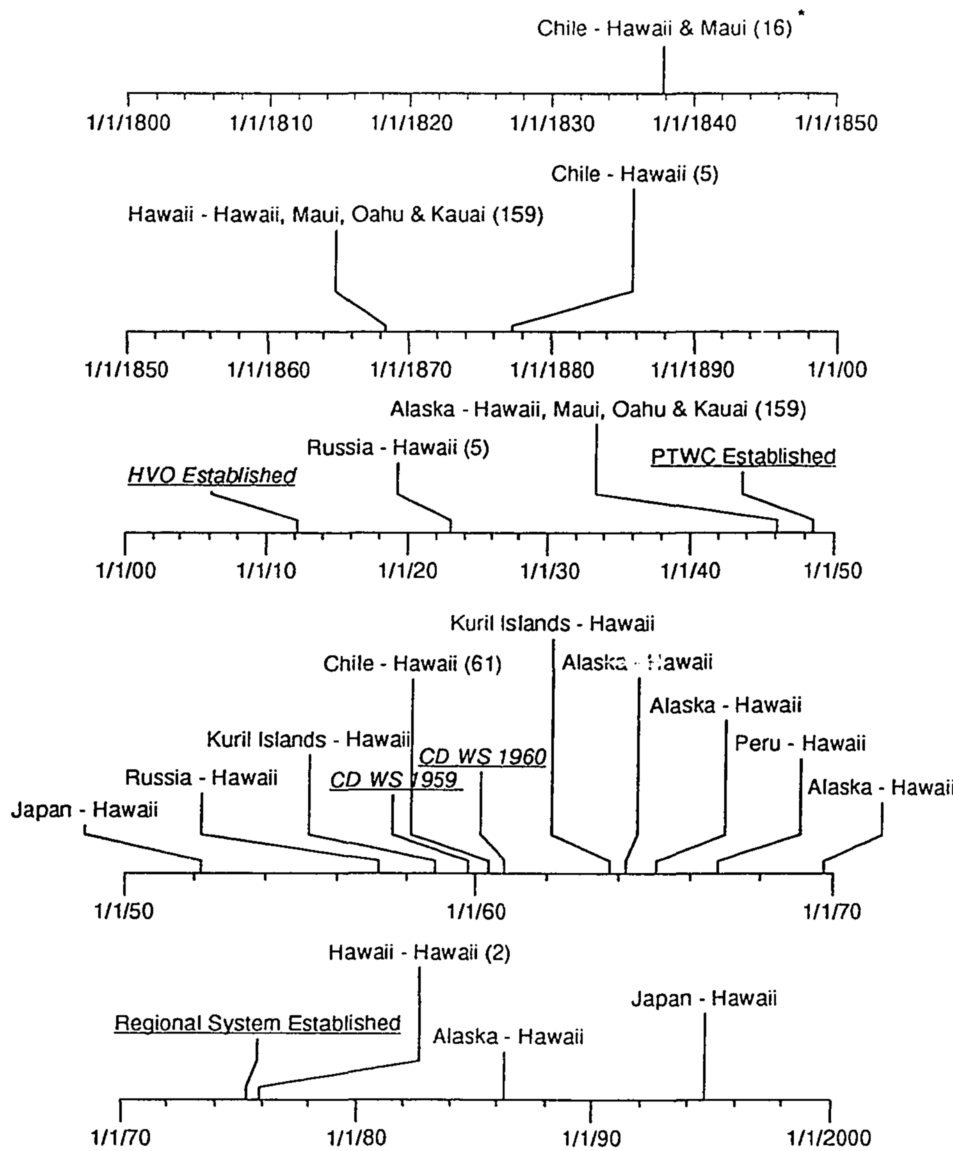


Figure B7. Chronology of tsunamis from 1800 to 1994 in Hawaii.
* originating source - Hawaiian Island(s) impacted (deaths)
[Hawaii Volcano Observatory (HVO), Pacific Tsunami Warning Center (PTWC), Civil Defense Warning System changes (CD WS)]

Note. Cox, D. C. (1987). Tsunami casualty and mortality in Hawaii. University of Hawaii, Hawaii Institute of Geophysics, Environmental Center, SR: 0040, HIG-87.

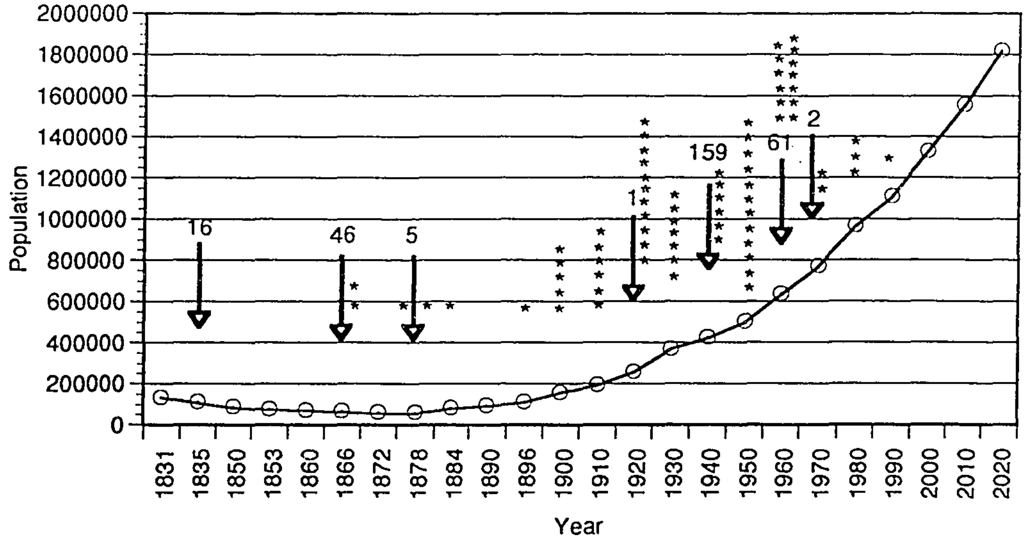


Figure B8. A comparison of the population distribution of the State of Hawaii with the number of deaths associated with the major tsunamis which have struck the the Hawaiian Islands from 1831-1990 (thick arrows).Tsunamis (>20 cm) which did not cause deaths are denoted by (*).

Note: The City and County statistics were obtained from the "State of Hawaii data book: A statistical abstract", 1992. Department of Business, Economic Development and Tourism, Honolulu, HI.

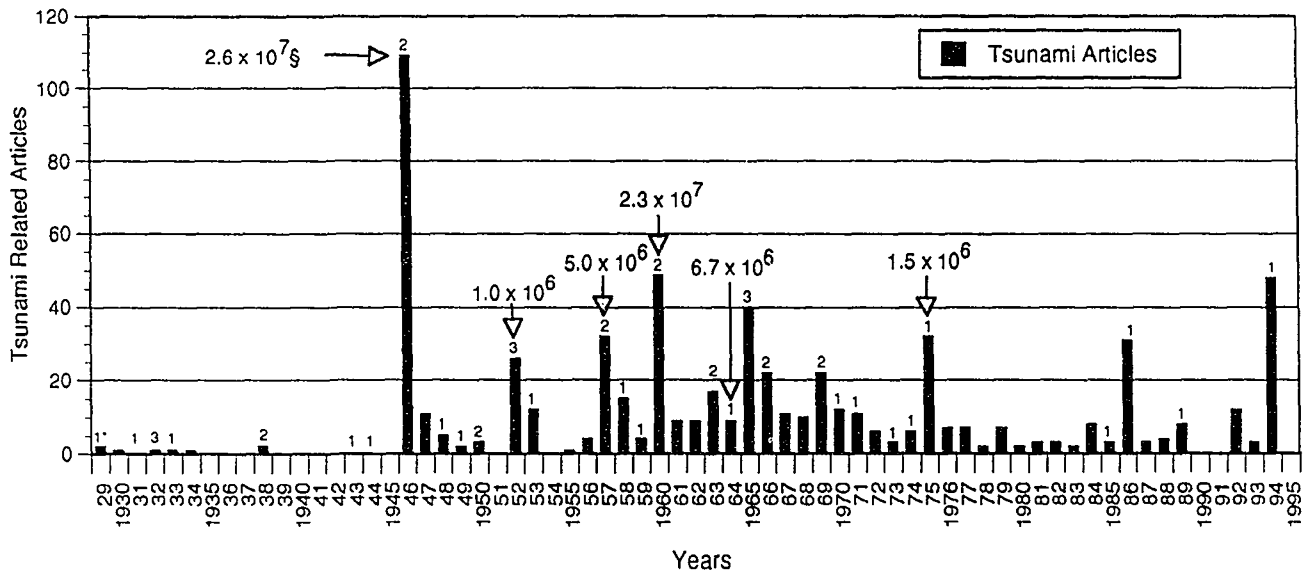


Figure B9. Total number of tsunami related articles in the Honolulu Advertiser and Star Bulletin Newspapers (1929 -1995)

* total number of tsunamis affecting Hawaii (local and distant)

§ property damage (dollars)

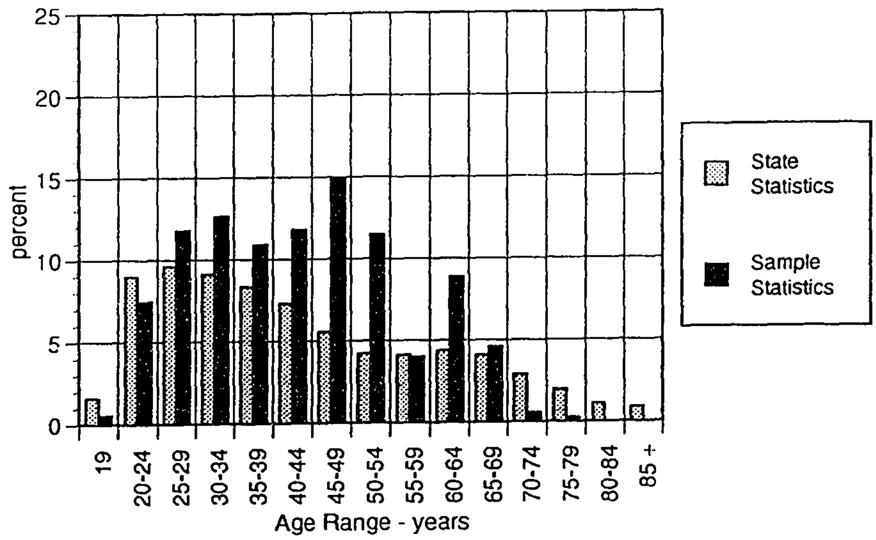


Figure B10. A comparison of the age distributions of the population of the City and County of Honolulu, Oahu, Hawaii with the sample obtained from the First Circuit Court of Honolulu, HI.

Note. The City and County statistics were obtained from "State of Hawaii Data Book: A Statistical Abstract", 1990, Department of Business, Economic Development and Tourism. Honolulu, HI.

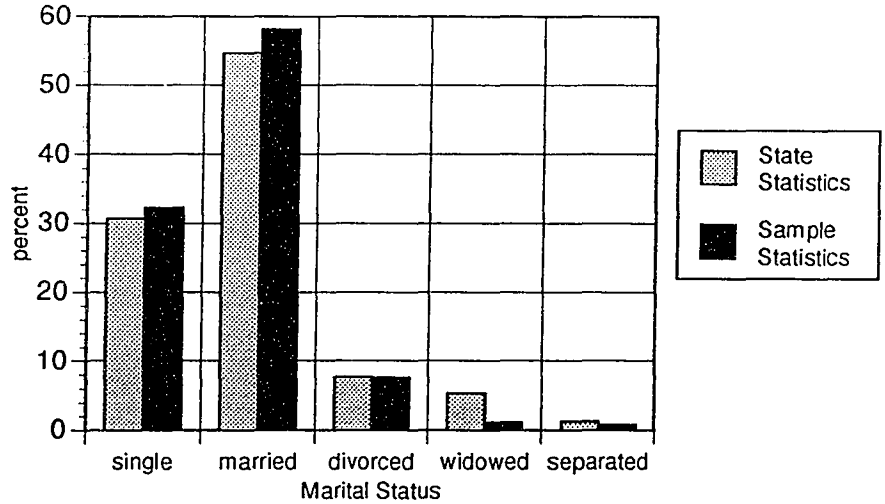


Figure B11. A comparison of the marital status of the population of the City and County of Honolulu, Oahu, Hawaii with the sample obtained from the First Circuit Court of Honolulu, HI.

Note. The City and County statistics were obtained from "State of Hawaii Data Book: A Statistical Abstract", 1990, Department of Business, Economic Development and Tourism. Honolulu, HI.

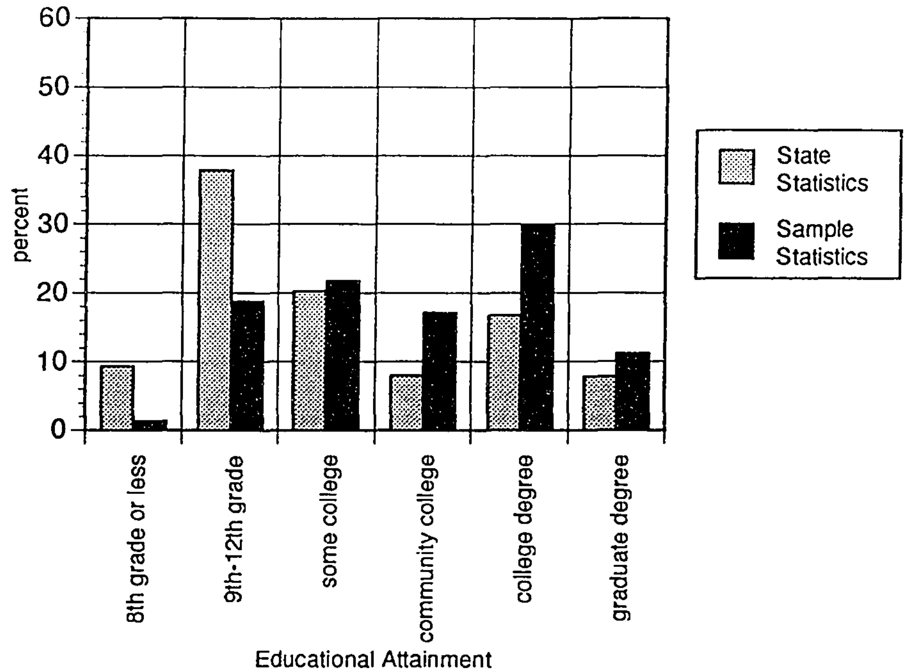


Figure B12. A comparison of the educational attainment of the population of the City and County of Honolulu, Oahu, Hawaii with the sample obtained from the First Circuit Court of Honolulu, HI.

Note. The City and County statistics were obtained from "State of Hawaii Data Book: A Statistical Abstract", 1990, Department of Business, Economic Development and Tourism. Honolulu, HI.

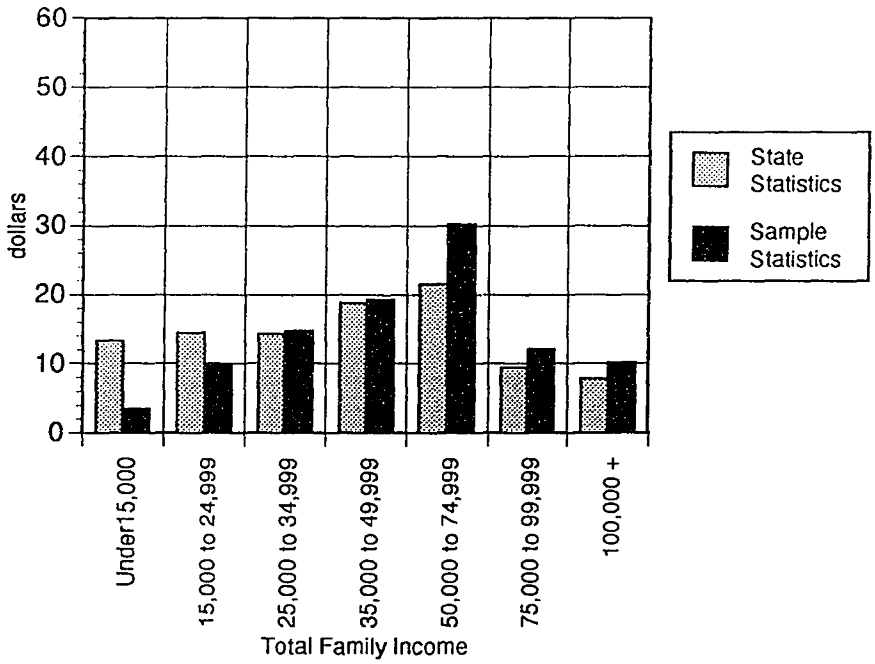


Figure B13. A comparison of the total family income of the population of the City and County of Honolulu, Oahu, Hawaii with sample obtained from the First Circuit Court of Honolulu, HI.

Note. The City and County statistics were obtained from "State of Hawaii Data Book: A Statistical Abstract", 1990, Department of Business, Economic Development and Tourism. Honolulu, HI.

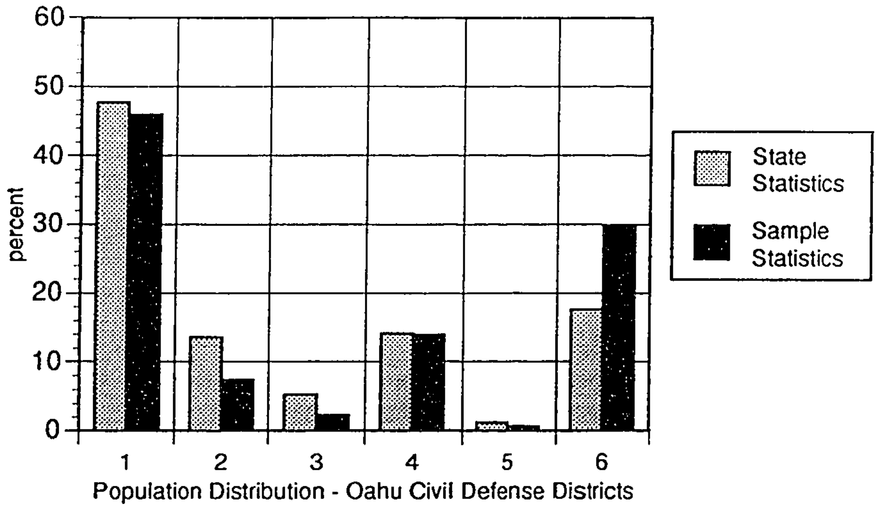


Figure B14. A comparison of the population distribution of the City and County of Honolulu, Oahu, Hawaii with the sample obtained from the First Circuit Court of Honolulu, HI.

Note. The City and County statistics were obtained from "State of Hawaii Data Book: A Statistical Abstract", 1990, Department of Business, Economic Development and Tourism. Honolulu, HI.
District 1. Honolulu Area
District 2. Waialua Area
District3. Maile Area
District4. Kailua Area
District5. Kahuku Area
District6. Pearl City Area

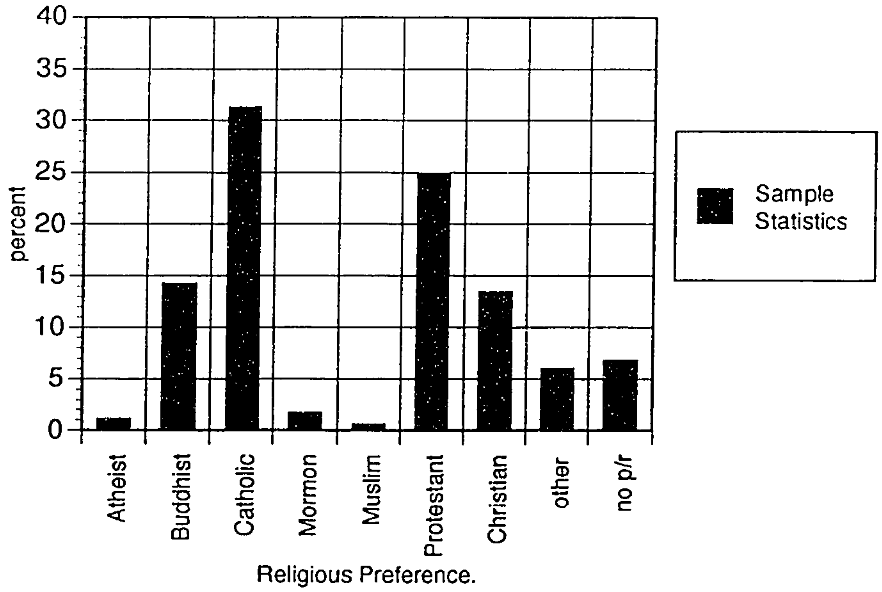


Figure B15. The religious distribution of the sample obtained from the First Circuit Court of Honolulu, HI.

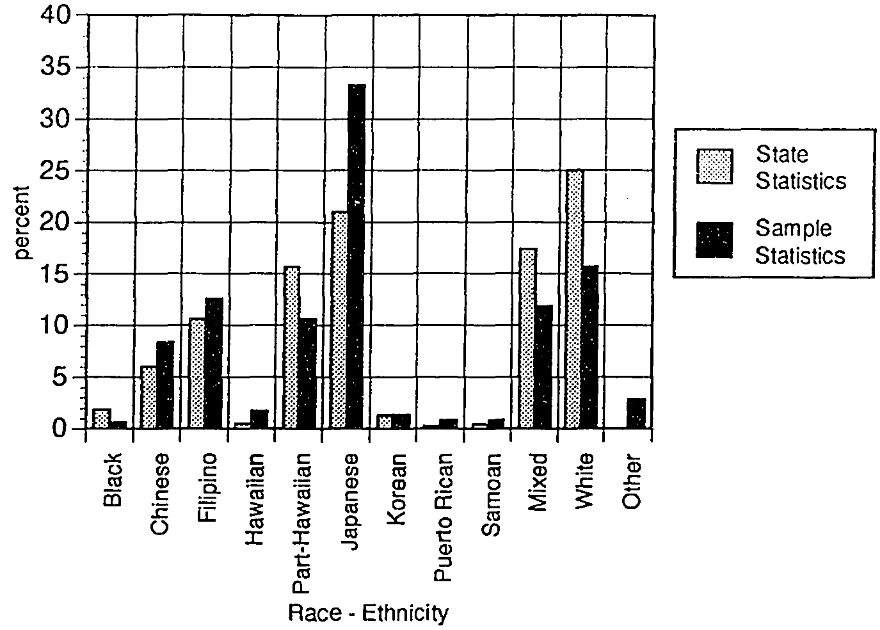


Figure B16. A comparison of the race - ethnicity of the population of the City and County of Honolulu, Oahu, Hawaii with the sample obtained from the First Circuit Court of Honolulu, HI.

Note. The City and County statistics were obtained from "State of Hawaii Data Book: A Statistical Abstract", 1990, Department of Business, Economic Development and Tourism. Honolulu, HI.

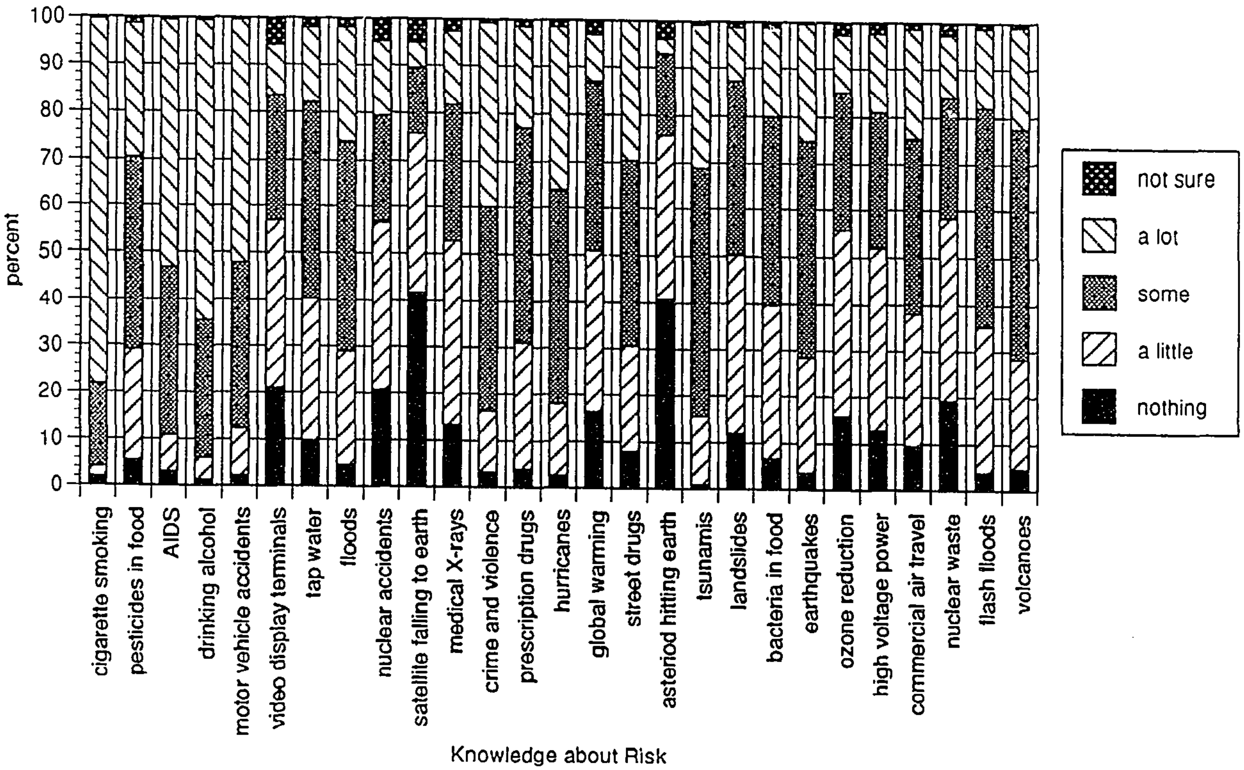


Figure B17. Knowledge about 27 natural and technological risks from the sample obtained from the First Circuit Court of Honolulu, HI.

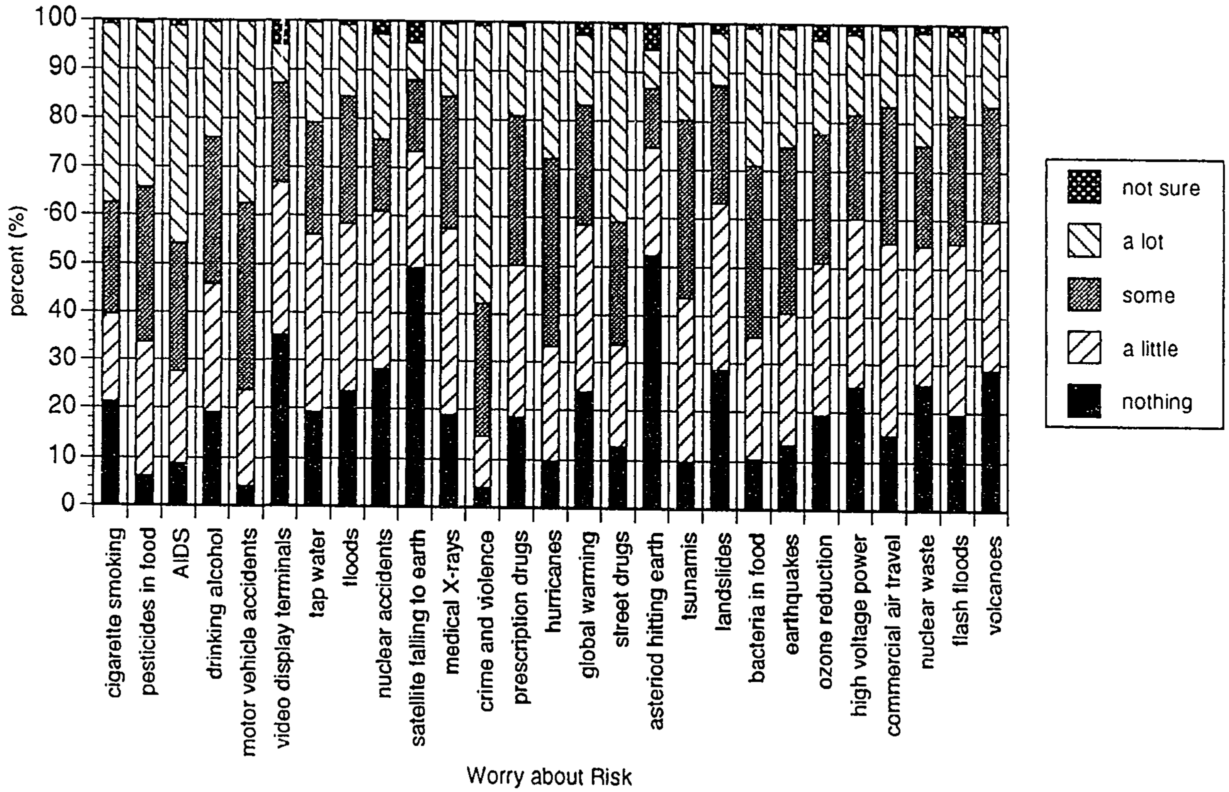


Figure B18. Worry about 27 natural and technological risks from the sample obtained from the First Circuit Court of Honolulu, HI.

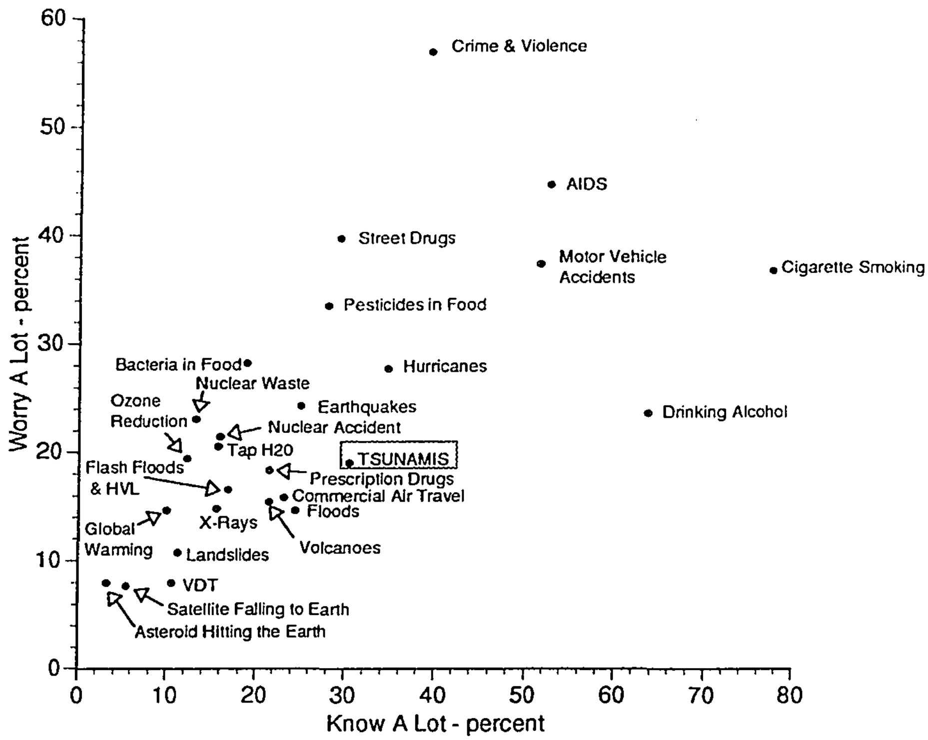


Figure B19. Knowledge (a lot) and worry (a lot) about 27 natural and technological risks from the sample obtained from the First Circuit Court of Honolulu, HI.

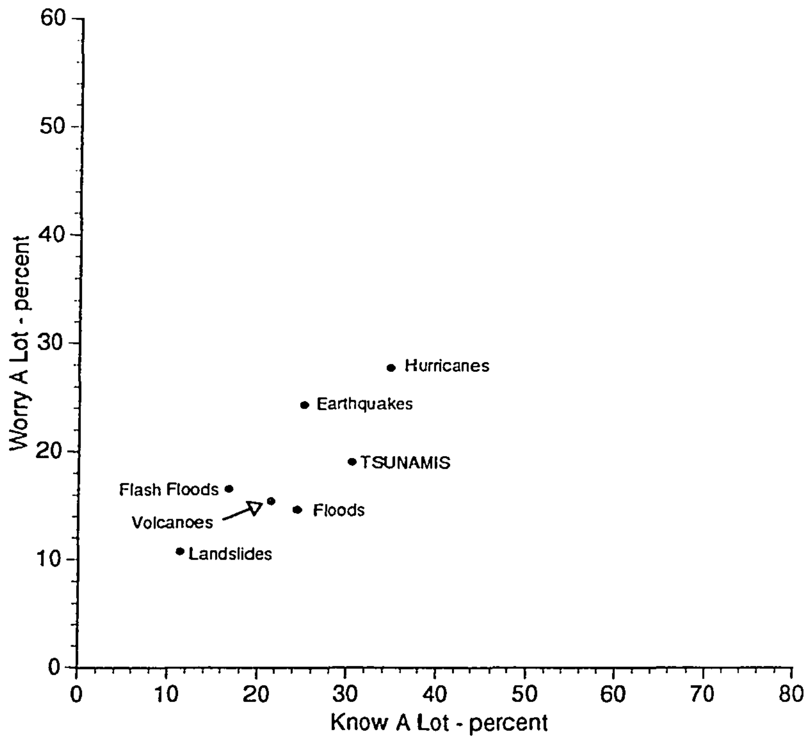


Figure B20. Knowledge (a lot) and worry (a lot) about 7 natural risks from the sample obtained from the First Circuit Court of Honolulu, HI.

APPENDIX C

GLOSSARY OF TERMS *

Amplitude. (n) Oscillation of the height of the sea surface. Often amplitude is determined by one-half the total observed rise or fall (wave height).

Arrival Time. (n) The time of the arrival of the first wave of the tsunami at the location of effects given in day, hour, and minutes.

Atsunamic. (adj.) Characterized by a lack of the features typical of a tsunami.

Bathymetry. (n) The measurement of depths of water in oceans, seas and lakes.

ESL. (acronym) English as a Second Language.

ETA. (n) Estimated time of arrival.

Evacuation Map. (n) A map which indicates areas for which planned actions are to be undertaken in case a tsunami becomes recognized as a hazard.

Evacuation Zoning. (n) Zonation of land in which the maximum number of individuals are removed before impact of the first tsunami wave.

Forecast. (n) The subjective estimates of quantitative parameters of an event for which the results are unknown, usually in the future. A forecast procedure is not fully teachable.

GEOS. (n) acronym for Geosynchronous Orbiting Satellite or Geostationary Orbiting Satellites.

GOES. (n) acronym for Geostationary Operational Environmental Satellite. These satellites have specific functions designed for meteorological, communications, scientific, earth resources, navigation or earth imaging purposes.

Hazard. (n) Potential harm from a substance, agent or physical event which has the ability to cause some type of an adverse health effect.

Hazardicity. (n) The relative level of risk from a tsunami, not usually perceived exactly.

Honolulu Observatory. (n) Organization at Ewa Beach, Oahu, which serves as communication and analysis center for tsunami data for the Pacific Basins. Now called the Pacific Tsunami Warning Center (PTWC).

Inundation. (n) The depth (relative to a stated reference level) to which a stated location is covered by water

Local Tsunami. (n) A tsunami within one wave length of the point of origin of observation.

Magnitude. (n) The strength of the tsunami based on the maximum wave amplitude of the source.

Micro-tsunami. (n) A tsunami of such small amplitude that it must be observed instrumentally; not detectable visually. The normalized wave of less than two decimeters but more than two centimeters from peak to trough.

Microzonation. (n) The detailed designation of zones, either by tsunami risk or tsunamicity.

Mini-tsunami. (n) The normalized wave of less than two meters but more than two decimeters from the peak to the trough (observed).

Period. (v) The time between two successive crests or troughs usually given in minutes.

Prediction. (n) The action of results of estimating objectively some quantitative parameters of events, for which the results are unknown, usually in the future. A prediction procedure is teachable.

PTWC. Acronym for the Pacific Tsunami Warning Center.

Risk. (n) The probability that a potential hazard will be realized.

Run-up. (n) The height above high-high water level (hhwl), measured vertically, to the level of the highest wetted land or structure.

Seiche. (n) An oscillation of the surface of a lake or landlocked sea, varying in period from a few minutes to several hours. Seiches may also impact harbors, bays, headland-protected coves, rivers, canals and breaking inlets.

Swash. (n) A dashing of water against or on something (RE: Lituya Bay, 1958).

Tele-tsunami. (n) A tsunami originating at a distance of more than one wave length from the point of observation or 1,000 kilometers from their source.

Topography. (n) The art and practice of graphic delineation in detail usually on maps or charts of natural and man-made features of a place or region especially in a way to show their relative positions and elevations.

Travel Time. (n) The time in hours and tenths of hours that it took the tsunami to travel from its source to location of effect.

Tsunami. ("harbor wave" - Japanese). The gravity wave generated by the vertical component of a relative motion within the earth or ocean. This definition can be used to describe a wave generated by seismic origin, anthropogenic sources (i.e., bombs) and extraterrestrial impacts (meteorites).

Tsunami. (n) (generic) (n) Having a wave of more than two meters peak to trough, observed, or normalized to, one thousand kilometers from the source area.

Tsunamiable. Having the potential of giving rise to a tsunami.

Tsunamiage. (n) Extent of land surface covered at least once by waves of a tsunami, as measured above mean high-high sea level.

Tsunamiative. (a) Having the propensity to generate tsunamis.

Tsunamiation. (n) The act of generating a tsunami.

Tsunamiator. (n) The generator of a tsunami.

Tsunamic. (adj.) Having features analogous to those of a tsunami or description of a tsunami.

Tsunamicity. (n) The propensity of a specified region to generate tsunamis.

Tsunamigenesis. (n) The generation of a tsunami.

Tsunamigenic. (adj.) Having demonstrated or potential capability to generated a tsunami.

Tsunamimetry. (n) The study of the instrumentation for detecting and measuring some parameter of tsunami.

Tsunamion. (n) The quantum of tsunami energy).

Tsunamious. (adj.) Evidencing a tendency to be a source of tsunami energy.

Tsunamitite. (n) Any geological material deposited by a tsunami.

Tsunami Engineering. (n) The practice of designing structures to be tsunami resistant.

Tsunami Magnitude. (n) The size of a tsunami

Tsunamiologist. (n) An individual who studies tsunamis.

Tsunami-prone. (a) Anomalously receptive to tsunamis.

Watch Bulletin. Issued when a seismic event has been detected which is of sufficient magnitude and in such a location that the generation of a tsunami is possible.

Warning Bulletin. Issued by PTWC upon receipt of positive evidence that a tsunami exists. Contains estimated times of arrival at tide stations in the Warning System.

Watch Cancellation. Bulletin issued when PTWC determine that a wave has not been generated.

Warning Cancellation. Bulletin issued by PTWC to indicate that; (1) warning was issued on basis of erroneous data, (2) only an insignificant wave has been generated and (3) a significant wave has been generated but poses no threat to one or more of the areas the PTWC warns.

Zoning. (n) Zonation. The petitioning of land areas into different zones deemed to be different with respect to risk from tsunamis, or to tsunamicity.

* Adams, W. M. & Nakashizuka, N. (1985). A working vocabulary for tsunami study. Science of Tsunami Hazards 3(1): 45-51.

Lander, J. F., Lockridge, P. A. & Kozuch, M. J. (1993). Tsunamis affecting the west coast of the United States (1806-1992). Boulder, CO: United States Department of Commerce, National Oceanic and Atmospheric Administration, Geophysical Records Documentation No. 29.

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APPENDIX D

THE SELECTION OF HONOLULU'S CIRCUIT COURT JURORS*

This survey by Ward Research of Honolulu's jurors indicates that out jury panels are not a mirror reflection of the diversity of this island's population. Persons of Japanese ancestry are overrepresented dramatically and Caucasians are also somewhat overrepresented on the juries. Hawaiians and part-Hawaiians are dramatically underrepresented and Filipinos, Koreans, and Samoans are also underrepresented. Persons over 35 are overrepresented and persons under 35 are underrepresented - especially those under 25. The median household income of the average juror is almost 20 percent higher than that of the average island resident, with persons in households making less than $15,000 dramatically underrepresented. Blue-collar workers and farmers are also underrepresented. And in the education category, a substantially greater percentage of jurors have been to college than the population as a whole, and persons with only a grade school education are not likely to be found on our juries as well.

Why is the demographic makeup of our juries different from that of the population as a whole? Are these differences great enough to cause concern. Are they likely to affect the verdicts of our jury panels?

Jurors are selected in three stages: the officials in the jury clerk's office compile a list of names of prospective jurors (the jury wheel); they and the judges grant excuses to some of those who are called; and then the competing attorneys challenge still more of them. Each stage can introduce or increase a disproportionate representation of identifiable groups.

The Jury Wheel

The jury wheel in the First Circuit Court (Honolulu) contains names taken from the list of registered voters combined with the list of holders of drivers licenses, and the names of about 100 volunteers are added each year as well. The voter list is an administratively convenient source, but if it were used alone, it would underrepresent the poor, the less educated, the young and some minority ethnic groups, which register to vote at substantially lower rates than the rest of the population. The percentage of the population which registers to vote has fluctuated nationally between 66 and 74 percent, and the percentage that actually votes ranges from about 52 to 55. The percent that has drivers licenses is substantially higher, and the combination of voter and drivers lists will usually produce a representative jury wheel. Supplementation of the voter list also avoids the problem of making jury duty a "penalty" for voting. [Note: a list of taxpayers has since been included in the jury wheel (1994)]

Honolulu's jury clerk selects 38,000 names from this jury wheel and sends a questionnaire to this group asking for information designed to determine whether they are qualified for jury duty. The questionnaires which are returned are examined to see if the person is disqualified for any reason (e.g., not a citizen, under 18, unable to speak English, disabled) or if a statutory exemption is claimed. Doctors, dentists, lawyers, ministers, active-duty military, police officers, fire fighters, judges, elected officials, and the heads of executive departments are entitled to apply for an exemption. They are also allowed to serve if they choose not to apply for an exemption. (Even Hawaii's limited list of exemptions may be too long - in many states, police officers, lawyers, and even judges have served as jurors without causing significant problems.) After the disqualification's and exemptions are examined from the returned questionnaire, 27,000 qualified persons remain in the First Circuit Court's jury wheel.

The Excusing Process

From this 27,000 a total of 9,000 names are randomly selected and these persons are sent summonses during the course of the year asking them to report for service. At this point, they can request to be excused if they feel jury service would impose a "serious personal hardship". Persons who are not excused are on call as jurors for 30 days, and they will be asked to report to the courthouse on 10 separate days during that period, sitting, on the average of two to three trials. For their service, they receive $20 per day plus 20 cents per mile from their home to the courthouse (one way).

This excusing stage can be an important one in terms of ensuring that the jury is representative of the community. Although jury service is supposed to be a right and privilege of citizenship, most people consider it a nuisance. Being a juror is time-consuming, inconvenient, and frequently a financial hardship. The Hawaii statute states that prospective jurors should not be excused for "slight or trivial cause", and that excuses if granted should be temporary if possible. It is important that excuses be granted only when real hardships exist., because otherwise jury service would turn into a voluntary matter and only those persons with time on their hands or a particular interest in the judicial system would serve. It is also important that efforts be made to pursue persons who do not return their questionnaires with a second notice in order to have as complete a cross-section as possible. A jury selection process that does not affirmatively reach out to include all members of the community will not produce the impartial juries required by the Sixth Amendment of the U. S. Constitution and Article I, Section 14, of Hawaii's constitution.

The very modest pay for jurors creates a hardship for many, although some employees continue to receive their normal salaries during jury duty. White-collar professionals are much more likely to continue to receive their pay than blue-collar workers; and the larger the employer, the more likely it is that employees will be paid during their jury duty. Most public employees in Hawaii receive their pay while serving on juries and the Ward Research Survey, discovers, for instance, a disproportionately large numbers of teachers among the occupations of their survey group. The economics of jury service can, therefore, introduce disparities between the jurors and the general population. One approach that has worked well in Massachusetts is to require employers to continue paying an employee during the first two days of jury service, and then for the state to pay jurors a relatively large daily fee if they are selected for a trial requiring them to serve for more than two days. Even aside from monetary considerations, the prospects of a long period of service may discourage most people from willingly serving as jurors. An on-call system can be disruptive because the calls are not predictable, and thus prospective jurors cannot arrange their lives with certainty. The courts that require a month of jury service do so on grounds of administrative convenience, arguing that the first day of service is frequently taken up with procedural matters and that once a juror is selected, qualified, summoned, and oriented, the court wants to use the juror for an extended period.

In order to reduce the hardship on prospective jurors and produce more representative jury panels, an increasing number of progressive courts have been moving to a "one-day/one-trial" system. Under this system, each juror is called only for one day and sent into one trial. If selected, the juror serves for the duration of the trial (most trials are over in one or two days, but some are longer). If not selected, the person goes home and is not called again until drawn from the jury wheel at some future time. Such a system makes it much harder for a prospective juror to claim hardship and request an excuse from service, and the resulting jury panels are more likely to reflect the diversity of the community. Although this procedure has been suggested for Hawaii's courts, the State Legislature has thus far decided against adopting this innovative approach.

<u>Voir Dire and Challenge</u>

The litigants in the trial may challenge a prospective juror "for cause", and the person in question will be removed from the jury panel if the judge agrees that the prospective juror has some deep-seated bias or partiality that would interfere with a fair evaluation of the evidence. The court's acceptance of a challenge for cause will depend upon a finding of specific bias (for example, a potential juror's relationship to the defense, prosecution, or witnesses) or nonspecific bias (for example, prejudicial views on race or religion) that might play a part in the case.

Litigants can also exercise a set number of "peremptory challenges" to remove prospective jurors who appear unsympathetic to their cause, without giving any reason whatsoever. In Hawaii, each side is allowed three peremptory challenges in both civil and criminal trials, unless a defendant is facing life imprisonment in which case each side is allowed 12 challenges.

Challenges can sometimes serve to restore balance when the process of selecting jurors had distorted the demographic profile of the jury panel, as is often the case. They may, however, make the jury less representative than the original jury wheel, even to the point of removing all members of a race or group from the jury. If the jury panel sent into the courtroom is indeed representative, and does fairly reflect the community's diverse biases, challenging certain jurors because of their prejudices may alter the cross section of views represented.

Prior to the exercise of challenges, the attorneys, the judge, or both, question the prospective jurors about their backgrounds and views. This questioning procedure is known as the "voir dire", an ancient term variously translated as "to speak the truth" or 'to see what is said". The process of questioning varies widely from court to court; in federal courts judges tend to control the questioning, but in Hawaii's state courts and those of many states the attorneys question the jurors directly.

<u>Conclusion</u>

The use of the jury in the English speaking world as an institution of self-governance for eight hundred years is a powerful statement of commitment to democratic institutions. Decision making by citizens provides a level of common sense and a stamp of democratic legitimacy that cannot be attained by "experts", no matter how skilled they may be. Discretion and sound judgment must be exercised by some group, and our society has found that these decisions are made in the most reliable fashion if made by a representative group of ordinary persons with no personal ambition or stake in the matter. These goals can be achieved, however, only if our selection process produces representative panels. Only such a random sample of community members can render judgments that are truly impartial, reflecting the community's norms and collective conscience.

The selection process of the First Circuit Court in Honolulu is sound in most respects and is certainly carried out in a conscientious fashion by the court's jury clerks. Some disparities nonetheless exist between the jurors selected and the population at large and efforts should continue to find new ways that can produce panels that are more representative of our diverse population.

Specific ideas that might increase the representative quality of Hawaii's juries include the following: a) send a second questionnaire to those who do not respond to the first one they receive, b) adopt the "one-day/one-trial" approach toward jury service, c) eliminate all statutory exemptions, d) pay jurors more and e) grant excuses only on a temporary basis (unless the person has a disabling medical condition).

* Van Dyke, J. (1985). A demographic profile of Hawaii circuit court jurors. Honolulu, HI: Ward Research.

APPENDIX E

EMERGENCY PREPAREDNESS HANDBOOK (vol. VI)*

I) Purpose

Establish guidance to prepare the Department of Education for response to a distant or urgent (local) tsunami.

II) General

A) Tsunami, although infrequent, are capable of causing severe damage and devastation along the low flood-prone coastal areas of the State. Collapse of utility poles and bridges, as well as widespread flooding, could cut off electric power and communications and close many roads, streets, and highways along affected coastal areas. Department of Education facilities located in these areas are vulnerable to tsunami ocean waves that can rush inland at high speeds with devastating force.

B) When generated by distant earthquakes occurring along the pacific rim, a tsunami is detectable and a notification of an approaching tsunami will be provided by the Pacific Tsunami Warning Center (PTWC) to State Civil Defense and each County Warning Point (CWP). Civil defense agencies that ensure that the appropriate Tsunami Watch or Warning instructions are broadcasted to the public. State and county civil defense agencies provide appropriate notification to the Department of Education.

C) A tsunami generated by a strong earthquake locally anywhere in the State may reach the nearest coastline in a matter of minutes. The earthquake itself must be considered as a tsunami warning for all schools and Department of Education facilities throughout the State with protective of life being of the highest priority.

D) Any violent earthquake that would require a person to hold on to something to keep from falling or causes a person to fall is a natural warning of an Urgent (Local) Tsunami. People should evacuate from low-lying areas to higher grounds along the coastline as soon as the shaking stops.

E) Employees, their families and the general public should immediately turn on their radios or television upon hearing the civil defense Attention/Alert Signal and listen for civil defense instructions.

F) Activation of Departmental communications procedures will be in accordance with the basic plan (¶ XII).

III) Protective Action

A) Departmental civil defense coordinators shall devise a plan outlining a staggered work release schedule for employees who reside in potential tsunami and related flood-prone inundation areas and absolutely must return to their homes to complete necessary risks.

B) Employees about to be released during period of normal working hours shall be instructed that travel from the work place to place of residence could be hindered or come to a complete standstill due to traffic flow problems created by vehicle accidents and the sudden mass movement of vehicular traffic on the public street and highway systems.

C) Although they shall be discouraged from traveling, employees shall be instructed to exercise caution when traveling through tsunami and related flood-prone inundation areas and to be prepared to move to higher grounds in event of vehicle breakdown or involvement in a complete traffic stoppage prevents further movement by vehicle.

D) If located in an inundation zone when evacuation is directed, employees have two choices:

1) If in a multi-story building of heavy concrete and steel, move to the third floor or higher.

2) Evacuate to a safe location outside the zone.

E) If located outside of an inundation zone, employees should remain in place.

F) During the emergency period or potential disaster situation, do not use the telephone unless it is absolutely essential.

G) Keep the roads clear for emergency vehicles and those who absolutely must travel.

H) Administrators at all levels throughout the Department of Education shall, from the onset of Tsunami Watch notification, implement measures to alert employees to the emergency situation.

I) Administrators should exercise all precautionary measures possible from the time a Tsunami Watch notification goes into effect to the receipt of a Tsunami Warning notification and until the "ALL CLEAR" has been announced.

J) Employees should advise their administrators of any personal or family injuries sustained, damage to or loss of personal property, or other problems caused as a result of the tsunami emergency so that prompt assistance can be rendered.

K) Employees should also be made aware that children at school will be under the care of the Department of Education until such time it is prudently safe to release them for busing or pick-up by parents and/or guardians. Past experience in the highly populated City and County of Honolulu indicate that the sudden release of children from schools combined with a traffic surge in all directions will only add to confusion, stress, and the endangerment to life and property.

L) The established civil defense procedure to alert the general public to approaching tsunami waves and estimated time of arrival (ETA) of the first wave are as follows:

1) Three hours prior to ETA of first wave arrival at any point of the State, the Attention/Alert Signal will be sounded on civil defense sirens throughout the State followed immediately by Tsunami Warning instructions over the state Emergency Broadcast System (EBS).

2) In intervals of two hours, one hour and thirty minutes prior to ETA of first wave arrival at any point of a county, the Attention/Alert Signal will be sounded on civil defense sirens by the county civil defense agency of the concerned county for evacuation purposes. Each sounding of the sirens will be followed by Tsunami Warning instructions over the County EBS.

IV) Response and Recovery Actions

A) Urgent (Local) Tsunami. Urgent Tsunami are generated by a local earthquake and gives little or no time for official warning by civil defense organizations. The following guidance is offered: "If the ground shakes so hard that you must hold onto something to keep from falling, you must assume that a local tsunami has been generated".

1) Evacuate from the Department of Education facilities in low-lying areas immediately upon receiving a Tsunami Warning notification by means of radio, television, sounding of Attention/Alert Signal over civil defense sirens, warning by police and fire department personnel, life guards, or when the shaking stops, as appropriate.

a) Do not wait for the sounding of civil defense sirens.

b) Do not wait to be released by your supervisor.

c) Evacuate to higher ground.

2) Do not return to the evacuated low-lying areas until the "ALL CLEAR" has been announced over the Emergency Broadcast System (EBS) and the streets, roads, and highways have been declared safe for travel.

3) Administrators will prepare for and carry out damage survey and assessment, personnel accounting, damage and casualty reporting, debris clearance, and repair and recovery operations, as required.

B) Distant Generated Tsunami. When a distant generated tsunami has been generated Tsunami Watch and Warning instructions will be disseminated to the Department of Education civil defense coordinators by State and county civil defense agencies. the Emergency Broadcast System (EBS) will report Tsunami Watch and Warning information and instructions during working and non-working hours.

1) Tsunami Watch Instructions (working and non-working hours).

a) The Department of Education civil defense coordinator shall activate Departmental procedures as soon as possible after notification.

1) Contact Oahu District civil defense coordinators with instructions to alert receptive District Superintendents.

2) Contact Hawaii, Maui, and Kauai District civil defense coordinators as applicable. Generally, they are contacted by the respective county civil defense agencies.

3) Contact Public Relations Office with instructions to inform the Superintendent.

b) The school complex telephone relay procedure will be effected throughout the districts.

c) Administrators and employees, as appropriate shall:

1) Monitor radio and television news reports for instructions.

2) Prepare for and, as necessary, relocate vital records and essential equipment to safe areas.

3) Understand that a Tsunami Warning can quickly follow a Tsunami Watch.

4) Ensure flashlights and portable hand-held radios and spare batteries are available and charges, as appropriate. Reserve stocks should be protected from the elements whenever practical.

5) Prepare to open evacuation centers as emergency shelters based on instructions provided by the county civil defense agencies or the American Red Cross.

d) All employees will prepare for the implementation of Tsunami Warning actions listed below or return to normal operating procedures upon cancellation of the Tsunami Watch.

2) Tsunami Warning Instructions.

a) All tasks required of the Tsunami Watch instructions should be completed or implemented.

b) Ensure the following is accomplished within two hours prior to the ETA of the tsunami ocean waves:

1) Employees that work in a tsunami inundation area shall turn off electricity, secure rooms and buildings, and evacuate to the predesignated assembly staging area or higher ground that is safe from tsunami ocean waves.

C) <u>Tsunami "ALL CLEAR" Actions</u>

1) Cancellation of a Tsunami Warning notification to include an <u>Urgent</u> (Local) Tsunami Warning is made only by the county civil defense

agency. State and County civil defense will make the cancellation announcement over the State and County EBS, respectively, and repeated as necessary.

2) Tsunami wave impact at any point within the State will be announced over the state and County EBS, respectively, and the portable public address systems of the emergency services. County EBS will provide appropriate “ALL CLEAR” instructions and provide up-to-date information concerning damaged areas, flooding, road closures, power and communication outages, public safety precautions, and travel restrictions. Departmental operational activities will respond to the EBS “ALL CLEAR” announcement as follows:

a) Employees not affected by a tsunami wave impact should be prepared to report to work as soon as practical or report as directed by the Superintendent.

b) District Superintendents shall ensure that administrators of schools in the tsunami wave impact areas initiate prompt action to:

1) Make an accounting of employees and their current situation.

2) Maintain Emergency Actions Log of Events and account for employee time, material, supplies, and equipment resources expended.

3) Assist in brief damage survey, assessment, repair and recovery teams on mission assignments and safety precautionary measures.

4) Determine interruption, deficiencies and capabilities and report results to the district offices for information and action, as appropriate.

5) Establish repair and recovery operations and employee emergency work schedule.

c) Department of Education employees operating from county Emergency Operating Centers (EOCs) shall keep the Superintendent's Office and the district offices informed of ongoing events and projected operations that have impact on the Department of Education.

d) News releases regarding Departmental response and recovery operations will be through the Public Relations Branch.

V) <u>School Tsunami Evacuation Plans</u>

A) Schools located in tsunami inundation zones should develop evacuation plans, including:

1) Pupil accounting.

2) Evacuation route.

3) Initial/final assembly areas.

4) Teachers/staff responsibilities and expectations.

5) Supervision.

6) Items needed.

7) Transportation plan (busing, as applicable).

8) Plan details to parents.

B) Periodic drills or exercises.

1) County civil defense agencies recommend the conducting of an annual tsunami evacuation drill for those schools located in tsunami inundation zones, preferably at the beginning of each school year.

2) An additional exercise is recommended and should be conducted at the beginning of each summer session for those schools in inundation areas to accommodate the assignment of new teachers and summer school students.

C) A copy of each affected school's most recent tsunami evacuation plan should be on file with the Safety and Security office and each respective district office.

VI) <u>Tsunami Guidelines</u>

A) If a tsunami warning is issued prior to school bus pick up or parent drop off, schools will remain closed.

1) School personnel and other Department of Education personnel should listen to the radio for further instructions regarding work, should an "All Clear" be given.

B) Procedure for after school bus pick up or parent drop off.

1) Schools in inundation zones will be evacuated to suitable evacuation centers, emergency shelters, or other predetermined safe locations as indicated in individual school tsunami evacuation plans.

2) All other schools will remain open.

3) Teachers, administrators, and support personnel in all schools will remain with the students under their care and be responsible for their safety and welfare until claimed by parents after the tsunami threat has passed.

4) Only if sufficient time is available prior to wave arrival and only if schools can be safely dismissed or closed at their regularly scheduled hours will these measures be deviated from.

VII) Schools to be Evacuated (located within inundation zones)

District/School	Telephone Numbers
Honolulu	
none	
Central District	
Haleiwa Elementary	637-4995/5833
Waialua Elementary	637-5282/5821
Leeward District	
Iroquois Point Elementary	499-2040/2640
Nanaikapono Elementary	668-1151/1642
Waianae High	696-4244/4240
Waianae Intermediate (to 2nd floor)	696-2922/4455
Windward District	
Aikahi Elementary	254-3805/4017
Hauula Elementary	293-5633
Kaaawa Elementary	237-8142
Kainalu Elementary	262-6926/6927
Laie Elementary	293-5311/5401
Lanikai Elementary	261-0044/5441
Pope Elementary	259-7071/7068
Hawaii District	
Kapiolani Elementary	935-1617
Keaukaha Elementary	935-1959

Maui District

Kamehameha III Elementary	661-0515
Kaunakakai Elementary	553-5425
Kilohana Elementary	558-8185

Kauai District

Hanalei Elementary	826-6266
Kekaha Elementary	337-1611
Waimea Canyon Elementary	338-1331

*Office of Business/Facilities & Support Service Branch, Department of Education, State of Hawaii RS 88-4898, October 1988.

APPENDIX F

Attitude and Perception Survey

Dear Survey Participant,

I am a Graduate Student at the University of Hawaii, School of Public Health. I am interested in your understanding of and perceptions about specific kinds of risk. Listed on the following pages are a number of questions. Would you please read each question carefully and then check your response in the box provided.

All information is VOLUNTARY and will be kept strictly CONFIDENTIAL. Your NAME or IDENTITY information will NOT be collected.

Thank you,

Laurence Raine MS, MPH, DrPH (ABD)

University of Hawaii
School of Public Health
1960 East-West Road
Honolulu, HI 96825
(808) 956-8491

RISK PERCEPTION SURVEY & DATA

Please check (√) the Appropriate Box

1) TSUNAMIS are -
(check ALL that apply)

- **26.1%** ☐ seismic sea waves
- **0.6%** ☐ air currents
- **0.3%** ☐ harbor waves
- **42.9%** ☐ tidal waves
- **1.7%** ☐ don't know

2) How OFTEN do tsunamis happen in HAWAII?

- **2.8%** ☐ frequently
- **67.2%** ☐ sometimes
- **26.6%** ☐ almost never
- **0.6%** ☐ never
- **2.8%** ☐ don't know

---

3) Where are TSUNAMI EVACUATION ZONES?

- **7.9%** ☐ in the mountains
- **40.9%** ☐ at the beach and/or shore
- **1.3%** ☐ along stream banks away from beach/or shore
- **48.7%** ☐ far away from the beach/or shore
- **1.3%** ☐ don't know

4) TSUNAMIS are CAUSED by -
(check ALL that apply)

- **2.2%** ☐ winds
- **59.7%** ☐ earthquakes
- **3.1%** ☐ landslides into the ocean
- **1.4%** ☐ volcano eruptions
- **2.0%** ☐ don't know

---

5) Do you LIVE in an EVACUATION ZONE?

- **22.1%** ☐ yes
- **73.1%** ☐ no
- **4.8%** ☐ don't know

6) Do you WORK in an EVACUATION ZONE?

- **34.2%** ☐ yes
- **62.2%** ☐ no
- **3.6%** ☐ don't know

---

7) Are you PERSONALLY at risk from a tsunami?

- **27.5%** ☐ yes
- **66.9%** ☐ no
- **5.6%** ☐ don't know

8) Do your CHILDREN go to a SCHOOL IN an EVACUATION ZONE?

- **10.4%** ☐ yes
- **87.9%** ☐ no
- **1.8%** ☐ don't know

---

9) Would you agree that PEOPLE are INJURED by TSUNAMIS because of their OWN ACTIONS?

- **20.6%** ☐ strongly agree
- **49.9%** ☐ agree
- **15.2%** ☐ undecided
- **13.2%** ☐ disagree
- **1.1%** ☐ strongly disagree

10) How OFTEN do TSUNAMIS HAPPEN AROUND the WORLD?

- **20.3%** ☐ frequently
- **61.6%** ☐ sometimes
- **7.9%** ☐ almost never
- **0.0%** ☐ never
- **10.2%** ☐ don't know

---

11) Do YOU know what will HAPPEN to YOU if you are PERSONALLY HIT by a TSUNAMI wave?

- **66.9%** ☐ yes (such as what) [Death or Injury]
- **30.8%** ☐ no
- **2.3%** ☐ don't care

Please check (√) the Appropriate Box

12) How well are the RISKS from tsunamis UNDERSTOOD by SCIENTISTS?

- 29.8 % ☐ definitely understood
- 56.5 % ☐ probably understood
- 9.1 % ☐ neither understood nor not understood
- 4.0 % ☐ probably not understood
- 0.6 % ☐ definitely not understood

---

13) Are the RISKS from tsunamis KNOWN to the GOVERNMENT?

- 39.3 % ☐ definitely known
- 51.1 % ☐ probably known
- 5.1 % ☐ neither known nor not known
- 4.0 % ☐ probably not known
- 0.6 % ☐ definitely not known

---

14) If YOU LIVE in an EVACUATION ZONE are YOU at RISK from a TSUNAMI?

- 70.5 % ☐ yes
- 24.6 % ☐ no
- 4.9 % ☐ don't know

15) On YOUR way TO or FROM WORK do you PASS THROUGH an EVACUATION ZONE?

- 48.2 % ☐ yes
- 43.4 % ☐ no
- 8.4 % ☐ don't know

---

16) Are YOU personally at RISK from a TSUNAMI when you are at the BEACH?

- 93.0 % ☐ yes
- 5.1 % ☐ no
- 2.0 % ☐ don't know

17) Are YOU personally at RISK from a TSUNAMI when you are OUTSIDE an EVACUATION ZONE?

- 26.3 % ☐ yes
- 63.3 % ☐ no
- 10.5 % ☐ don't know

---

18) Have YOU personally experienced a DESTRUCTIVE TSUNAMI?

- 5.9 % ☐ yes (explain [SEE TEXT])
- 94.1 % ☐ no

19) Do you know SOMEONE who has EXPERIENCED a DESTRUCTIVE TSUNAMI?

- 19.9 % ☐ yes (explain [SEE TEXT])
- 80.1 % ☐ no

---

20) If you are EXPOSED to a TSUNAMI can you CONTROL what HAPPENS to YOU?

- 13.8 % ☐ definitely can control
- 32.2 % ☐ probably can control
- 10.2 % ☐ neither control nor not control
- 26.8 % ☐ probably cannot control
- 11.6 % ☐ definitely cannot control
- 5.4 % ☐ don't know

21) If YOU are exposed to a TSUNAMI can YOU AVOID INJURY ?

- 9.3 % ☐ definitely can avoid injury
- 39.4 % ☐ probably can avoid injury
- 14.1 % ☐ neither can avoid nor cannot avoid injury
- 25.1 % ☐ probably cannot avoid
- 4.5 % ☐ definitely cannot avoid injury
- 7.6 % ☐ don't know

Please check (√) the Appropriate Box

22) PEOPLE should protect THEMSELVES from TSUNAMIS.

- 58.1 % ☐ strongly agree
- 36.2 % ☐ agree
- 3.4 % ☐ undecided
- 2.0 % ☐ disagree
- 0.3 % ☐ strongly disagree

23) THE GOVERNMENT should protect people from TSUNAMIS.

- 48.7 % ☐ strongly agree
- 43.1 % ☐ agree
- 5.0 % ☐ undecided
- 2.5 % ☐ disagree
- 0.6 % ☐ strongly disagree

---

24) How EASILY can the RISKS from TSUNAMIS be REDUCED?

- 17.6 % ☐ very easily
- 43.8 % ☐ somewhat easily
- 35.2 % ☐ not easily
- 3.4 % ☐ never

25) From YOUR experience the RISKS from TSUNAMIS ARE ...

- 13.9 % ☐ very new to me
- 26.1 % ☐ somewhat new to me
- 35.8 % ☐ neither new nor old to me
- 16.2 % ☐ somewhat old to me
- 8.0 % ☐ very old to me

---

26) Are you personally at risk from an approaching TSUNAMI WHEN YOU are AT the BEACH, SURFING, DIVING or FISHING?

- 56.2 % ☐ frequently
- 20.3 % ☐ sometimes
- 11.3 % ☐ almost never
- 7.6 % ☐ never
- 4.5 % ☐ don't know

27) How many people in HAWAII can be INJURED by TSUNAMIS?

- 6.2 % ☐ a few
- 12.4 % ☐ some
- 69.9 % ☐ a lot
- 11.5 % ☐ don't know

---

28) How many people in HAWAII CAN be KILLED by a TSUNAMI?

- 8.4 % ☐ a few
- 16.0 % ☐ some
- 61.5 % ☐ a lot
- 14.0 % ☐ don't know

---

29) We should PROTECT the safety of FUTURE GENERATIONS by LIMITING CONSTRUCTION located within EVACUATION ZONES.

- 25.6 % ☐ strongly agree
- 34.6 % ☐ agree
- 23.3 % ☐ undecided
- 14.3 % ☐ disagree
- 2.2 % ☐ strongly disagree

30) We should REDUCE the COSTS to FUTURE GENERATIONS by LIMITING CONSTRUCTION located within EVACUATION ZONES.

- 22.3 % ☐ strongly agree
- 32.9 % ☐ agree
- 25.4 % ☐ undecided
- 16.6 % ☐ disagree
- 2.9 % ☐ strongly disagree

---

31) Do you FEAR tsunamis?

- 23.2 % ☐ a great deal
- 40.3 % ☐ somewhat
- 23.8 % ☐ very little
- 10.6 % ☐ not at all
- 2.0 % ☐ don't know

32) Are you a RELIGIOUS or SPIRITUAL person?

- 49.4 % ☐ yes
- 25.3 % ☐ no
- 25.3 % ☐ sometimes

Please check (√) the Appropriate Box

33) When you are at the BEACH, SURFING, DIVING or FISHING do you THINK about the POSSIBILITY of a TSUNAMI?

- **2.2 %** ☐ frequently
- **18.2 %** ☐ sometimes
- **33.9 %** ☐ almost never
- **42.9 %** ☐ never
- **2.8 %** ☐ don't know

34) Do you UNDERSTAND how the TSUNAMI WARNING SYSTEM works?

- **84.3 %** ☐ yes
- **5.1 %** ☐ no
- **10.7 %** ☐ don't know

---

35) If the HAWAIIAN ISLANDS are EXPOSED to a LARGE TSUNAMI how much damage would occur?

- **54.4 %** ☐ definitely a lot of damage
- **40.3 %** ☐ probably a lot of damage
- **0.3 %** ☐ not much damage
- **0.6 %** ☐ probably not a lot of damage
- **0.0 %** ☐ definitely not a lot of damage
- **4.5 %** ☐ don't know

36) If YOU are exposed to a TSUNAMI can you avoid DEATH ?

- **15.3 %** ☐ definitely can avoid death
- **41.6 %** ☐ probably can avoid death
- **16.7 %** ☐ neither can avoid nor cannot avoid death
- **14.7 %** ☐ probably cannot avoid death
- **1.7 %** ☐ definitely cannot avoid death
- **9.9 %** ☐ don't know

---

37) What are the CHANCES of a TSUNAMI hitting the Hawaiian Islands in the next FEW MONTHS?

- **7.8 %** ☐ very likely
- **28.8 %** ☐ somewhat likely
- **24.9 %** ☐ somewhat unlikely
- **17.6 %** ☐ very unlikely
- **21.6 %** ☐ don't know

38) What are the CHANCES of a TSUNAMI hitting the Hawaiian Islands in the next FEW YEARS?

- **24.9 %** ☐ very likely
- **40.1 %** ☐ somewhat likely
- **13.4 %** ☐ somewhat unlikely
- **4.5 %** ☐ very unlikely
- **17.1 %** ☐ don't know

---

39) Do you know what the word INUNDATION means?

- **53.5 %** ☐ yes
- **39.4 %** ☐ no
- **7.0 %** ☐ not sure (could mean) ____________

40) During the October 4, 1994 tsunami did you HEAR the SIREN warning?

- **85.7 %** ☐ yes
- **10.4 %** ☐ no
- **3.9 %** ☐ not sure (please explain) [SEE TEXT]

---

41) Do you UNDERSTAND the difference between a TSUNAMI which is produced NEAR the Hawaiian Islands with those which come from FAR AWAY countries?

- **46.5 %** ☐ yes
- **22.1 %** ☐ no
- **30.5 %** ☐ not sure
- **0.8 %** ☐ don't care

42) Do you know what the word RUN-UP means?

- **25.8 %** ☐ yes
- **63.8 %** ☐ no
- **10.4 %** ☐ not sure (could mean) [SEE TEXT]

Please check (√) the Appropriate Box

43) If you were to HEAR the Civil Defense SIREN right NOW what would YOU do?
...........*(please rank 1st, 2nd 3rd)*

[SEE TEXT]
- ☐ Turn on the television
- ☐ Listen to the radio [1], [2]
- ☐ Call your family and/or friends
- ☐ Call Civil Defense
- ☐ Evacuate immediately
- ☐ Look in the Telephone Book for information [3]
- ☐ Do nothing - because you don't live in an evacuation zone

---

44) If you HEARD that a TSUNAMI was coming in **5 HOURS**, what would YOU do?
...........*(please rank 1st, 2nd 3rd)*

[SEE TEXT]
- ☐ Call your family or friends [3]
- ☐ Go to the ocean to watch the tsunami arrive
- ☐ Return to your house to collect some belongings
- ☐ Stock up on food and other necessities [1], [2]
- ☐ Evacuate to higher ground to watch the tsunami arrive
- ☐ Go to a Civil Defense shelter
- ☐ Go to a friend's house outside an evacuation zone and await further instructions
- ☐ Not worry because you don't live in an evacuation zone
- ☐ Stay in your house even though you live in an evacuation zone (please explain) ________

---

45) If you HEARD that a TSUNAMI was going to **HIT** the HAWAIIAN ISLANDS in **10 MINUTES**, and you LIVE in an EVACUATION ZONE what would YOU do?
.............*(please rank 1st, 2nd, 3rd)*

[SEE TEXT]
- ☐ Call your family or friends to meet you in a safe place
- ☐ Go to the ocean to watch the tsunami arrive
- ☐ Return to your house to collect some belongings
- ☐ Evacuate to higher ground [1]
- ☐ Go to a Civil Defense shelter
- ☐ Go to a friend's house outside an evacuation zone and wait for further instructions [2], [3]
- ☐ Stay in your house even though you were advised to leave (please explain)

---

46) Your knowledge of TSUNAMIS is from -

[SEE TEXT]
- ☐ school [2]
- ☐ personal experience [3]
- ☐ television/radio [1]
- ☐ friends and relatives [5]

47) Do you think enough INFORMATION about TSUNAMIS is given on the RADIO or TV by CIVIL DEFENSE?

- 67.6% ☐ yes
- 20.3% ☐ no
- 12.1% ☐ don't know

---

48) Did anyone you KNOW put themselves IN DANGER during the October 4, 1994 TSUNAMI?

- 11.5% ☐ yes (such as how) ___[SEE TEXT]___
- 87.6% ☐ no
- 0.8% ☐ don't care - it's none of my business

Please check (√) the Appropriate Box

49) When you HEARD the tsunami SIREN WARNING on October 4, 1994 what did YOU do FIRST?
..........*(please check only ONE)*

- **2.0 %** ☐ Read the Telephone Book for information
- **64.9 %** ☐ Listened to the radio [1]
- **2.0 %** ☐ Called your family and/or friends
- **0.6 %** ☐ Telephoned Civil Defense
- **1.4 %** ☐ Evacuated to higher ground
- **25.8 %** ☐ Turned on the television [2]
- **2.6 %** ☐ Did nothing - because you don't live in an inundation zone [3]
- **0.8 %** ☐ Stayed in your house even though you live in an evacuation zone (please explain)

[SEE TEXT]

---

50) After you HEARD on October 4, 1994 that a TSUNAMI was coming in **5 HOURS**, what did YOU do FIRST?
..........*(please check only ONE)*

- **22.5 %** ☐ Called your family or friends [2]
- **0.0 %** ☐ Went to the ocean to watch the tsunami arrive
- **4.3 %** ☐ Returned to your house to collect some belongings
- **19.4 %** ☐ Stocked up on food and other necessities [3]
- **7.1 %** ☐ Evacuated to higher ground
- **0.6 %** ☐ Went to a Civil Defense shelter
- **2.6 %** ☐ Went to a friend's house outside an evacuation zone
- **40.5 %** ☐ Nothing - you don't live in an evacuation zone [1]
- **3.1 %** ☐ Stayed in your house even though you live in an evacuation zone (please explain)

[SEE TEXT]

---

51) When you HEARD that the October 4, 1994 TSUNAMI was going to **HIT** the HAWAIIAN ISLANDS in **10 MINUTES**, and you LIVE in an EVACUATION ZONE what did YOU do FIRST?
..........*(please check only ONE)*

- **14.5 %** ☐ Called your family or friends to meet you in a safe place [3]
- **0.6 %** ☐ Went to the ocean to watch the tsunami arrive
- **2.9 %** ☐ Returned to your house to collect some belongings
- **37.1 %** ☐ Evacuated to higher ground [1]
- **6.7 %** ☐ Went to a Civil Defense shelter
- **4.1 %** ☐ Went to a friend's house outside an evacuation zone
- **4.3 %** ☐ Stayed in your house even though you were advised to leave (please explain)

[SEE TEXT] 29.9 %

- ☐ Did nothing - because you don't live in an inundation zone [2]

---

52) Should people be FORCED to EVACUATE homes located within an evacuation zone when a TSUNAMI WARNING has been issued?

- **67.5 %** ☐ yes
- **20.7 %** ☐ no
- **11.8 %** ☐ don't know

53) Do you think enough is TAUGHT in the SCHOOLS about TSUNAMIS?

- **24.1 %** ☐ yes
- **37.3 %** ☐ no
- 8.7 % ☐ don't know

Please check (√) the Appropriate Box

54) What is your sex?

50.8 % ☐ female
49.2 % ☐ male

55-56) What YEAR were you BORN?

Range = 1920 to 1976 Average age = 42.5

Age Range = 19 to 75

---

57) Are you now:

32.3 %	☐ single	1.1 %	☐ widowed
58.1 %	☐ married	0.8 %	☐ separated
7.6 %	☐ divorced	0.0 %	☐ other ________

58) What LANGUAGE do you speak at HOME?

94.5 % ☐ English
5.5 % ☐ Other (Ilocano, Japanese, Chinese Tagalog, Vietnamese)

---

59) Do you have CHILDREN living with YOU?

51.8 % ☐ no
6.0 % ☐ yes (give number) ______
37.8 % ☐ yes (give number) (1-2)
8.7 % ☐ yes(give number) (3 >)
0.0 % ☐ sometimes (give number)

60) Do you have ELDERLY people living with YOU?

83.3 % ☐ no
1.1 % ☐ yes (give number) __
14.4 % ☐ yes (give number) (1-2)
1.1 % ☐ yes (give number) (3 >)
0.0 % ☐ sometimes (give number) ___

---

61) What is your HIGHEST level of EDUCATION?

0.0 % ☐ No School
0.8 % ☐ 6th grade or less
0.6 % ☐ 7th grade to 8th grade
18.8 % ☐ 9th grade to 12th grade
16.5 % ☐ Community College/Technical School
21.8 % ☐ Some College
29.7 % ☐ College Degree
11.2 % ☐ Advanced College Degree
0.6 % ☐ Other ________________

62) Which of these categories describes your TOTAL FAMILY INCOME?

3.4 % ☐ under $15,000
10.1 % ☐ $15,000 to $24,999
14.7 % ☐ $25,000 to $34,999
19.3 % ☐ $35,000 to $49,999
30.2 % ☐ $50,000 to $74,999
12.1 % ☐ $5,000 to $99,999
10.3 % ☐ $100,000 or more

---

63) How LONG have you LIVED in HAWAII?

2.0 %	☐ Less than 3 years	9.2 %	☐ 10-17 years
2.0 %	☐ 3-5 years	80.7 %	☐ 18 or more
6.2 %	☐ 6-9 years		

64) What CITY or TOWN do you LIVE in?

SEE TEXT

65) What ISLAND do you LIVE on?

OAHU

---

66) What is your RELIGION?

2.1 %	☐ Atheist	0.0 %	☐ Hindu	0.6 %	☐ Muslim	13.4 %	☐ Other [SEE TEXT]
14.2 %	☐ Buddhist	0.0 %	☐ Jewish	24.8 %	☐ Protestant	6.0 %	☐ Christian
31.3 %	☐ Catholic	1.7 %	☐ Mormon	0.0 %	☐ Shintoism	6.8 %	☐ No Pref/No Response

---

67) What is you RACE or ETHNIC HERITAGE?

0.6 %	☐ Black	10.6 %	☐ Part Hawaiian	11.8 %	☐ Mix - other than Part Hawaiian please specify [SEE TEXT]
8.4 %	☐ Chinese	33.3 %	☐ Japanese		
12.6 %	☐ Filipino	1.4 %	☐ Korean	14.3 %	☐ White
1.7 %	☐ Hawaiian	0.8 %	☐ Puerto Rican	2.2 %	☐ Other; please specify [SEE TEXT]
1.4 %	☐ Portuguese	1.4 %	☐ Samoan		________________

Please indicate how much you **KNOW** about the **RISKS** of each of the following items

	percent (%)				
	nothing	**a little**	**some**	**a lot**	**not sure**
1 Cigarette Smoking	2.0	2.2	17.7	77.8	0.3
2 Pesticides in Food	5.6	23.7	41.2	28.2	1.1
3 AIDS	3.1	7.9	35.7	52.8	0.6
4 Drinking Alcohol	1.4	4.8	29.5	63.8	0.6
5 Motor Vehicle Accidents	2.3	10.2	35.4	51.8	0.3
6 Video Display Terminals	21.2	35.7	26.6	10.8	5.7
7 Tap Water	9.9	30.5	41.8	15.3	2.5
8 Floods	4.6	24.5	44.7	24.5	1.7
9 Nuclear Accidents	20.7	35.9	22.7	16.0	4.8
10 Satellite Falling to Earth from its Orbit	41.8	33.9	13.8	5.6	4.8
11 Medical x-rays	13.4	39.2	29.1	15.7	2.5
12 Crime and Violence	3.4	13.0	43.5	39.5	0.6
13 Prescription Drugs	3.9	27.2	45.9	21.6	1.4
14 Hurricanes	2.8	15.2	45.8	34.8	1.4
15 Global Warming	16.4	34.7	35.7	10.2	3.1
16 Street Drugs	8.1	22.5	39.9	29.5	0.0
17 Asteroid Hitting the Earth	40.7	35.1	17.1	3.4	3.7
18 Tsunamis	1.1	14.6	53.1	30.6	0.6
19 Landslides	12.1	38.3	36.9	11.5	1.1
20 Bacteria in Food	6.7	33.1	40.1	19.0	1.1
21 Earthquakes	3.7	24.8	46.7	25.1	0.3
22 Ozone Reduction in the Atmosphere	15.8	40.0	29.3	12.4	2.5
23 High Voltage Power Lines	12.9	39.0	28.9	16.9	2.2
24 Commercial Air Travel	9.6	28.7	37.1	23.3	1.4
25 Nuclear Waste	19.3	39.2	25.5	13.4	2.5
26 Flash Floods	3.9	31.5	46.5	16.9	1.1
27 Volcanoes	4.8	23.5	49.3	21.6	0.8

Please indicate how much you **WORRY** about the **RISKS** of each of the following items

	percent (%)				
	nothing	**a little**	**some**	**a lot**	**not sure**
1 Cigarette Smoking	21.3	18.2	23.0	36.7	0.8
2 Pesticides in Food	6.2	27.6	32.1	33.5	0.6
3 AIDS	8.8	18.9	26.6	44.6	1.1
4 Drinking Alcohol	19.1	26.7	30.3	23.6	0.3
5 Motor Vehicle Accidents	4.2	19.6	38.7	37.3	0.3
6 Video Display Terminals	35.3	31.6	20.3	7.9	4.8
7 Tap Water	19.3	36.9	23.0	20.5	0.3
8 Floods	23.6	34.8	26.1	14.6	0.8
9 Nuclear Accidents	28.2	32.7	14.9	21.4	2.8
10 Satellite Falling to Earth from its Orbit	49.3	24.1	14.6	7.6	4.5
11 Medical x-rays	18.8	38.7	27.2	14.8	0.6
12 Crime and Violence	4.2	10.4	27.6	56.9	0.8
13 Prescription Drugs	18.5	31.7	30.6	18.3	0.8
14 Hurricanes	9.8	23.5	38.9	27.7	0.0
15 Global Warming	23.9	34.6	24.5	14.6	2.3
16 Street Drugs	12.7	21.1	25.4	39.7	1.1
17 Asteroid Hitting the Earth	52.3	22.3	12.1	7.9	5.4
18 Tsunamis	9.8	33.9	36.7	19.0	0.6
19 Landslides	28.7	34.6	24.2	10.7	2.0
20 Bacteria in Food	10.4	25.1	35.5	28.2	0.8
21 Earthquakes	13.3	27.4	34.2	24.3	0.8
22 Ozone Reduction in the Atmosphere	19.4	31.7	26.4	19.4	3.1
23 High Voltage Power Lines	25.2	35.0	21.3	16.5	2.0
24 Commercial Air Travel	15.2	40.0	28.2	15.8	0.8
25 Nuclear Waste	25.8	28.9	20.7	23.0	1.7
26 Flash Floods	19.6	35.6	26.3	16.5	2.0
27 Volcanoes	28.9	30.8	23.8	15.4	1.1

APPENDIX G

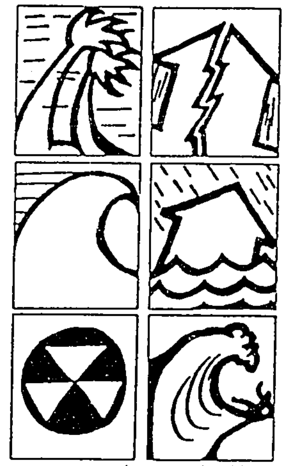
- Do you know the various natural and man-caused hazards to which you are exposed here on the Island of Oahu?
- During a major island-wide disaster, the first 36-72 hours are critical. Are you prepared to cope on your own for this period?
- Are you aware of the safe responses you and your loved ones should take when danger threatens?
- Have you prepared and exercised an emergency response plan for your household or business?
- Have you prepared a Survival Kit for your home or place of business to be used during an emergency?
- What actions should you take when the civil defense sirens are sounded?
- Do you know what role Civil Defense serves?

If you have any doubts about answering these questions, learn the answers now! Call your Civil Defense Agency.

DISASTER PREPAREDNESS: EVERYONE'S BUSINESS

Oahu Civil Defense Agency
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

OAHU CIVIL DEFENSE AGENCY
SPEAKERS BUREAU



For reservations or information please call
527-5489/523-4121

The Oahu Civil Defense Agency Speakers Bureau offers emergency preparedness instructions and briefings in the interest of public safety and education. Talks are normally 30-45 minutes followed by a question-and-answer period which extends the program to approximately one hour. Speakers may be requested for day, evening, or weekend engagements at no charge, subject to personnel availability.

1. **FUNCTION AND ROLE OF THE OAHU CIVIL DEFENSE AGENCY**
   An overview of statutes, ordinances, and charter provisions governing the Oahu Civil Defense Agency. The integrated emergency management system is explored along with specific natural and man-caused hazards to Oahu residents.

2. **DISASTER PREPAREDNESS**
   An evaluation of general and specific actions Oahu residents should take to prepare themselves and their families for various disasters and emergencies. The necessity for and contents of a survival kit are presented.

3. **TROPICAL STORM AND HURRICANE PREPAREDNESS**
   A discussion of the nature and effects of tropical cyclones. A review of past hurricanes and a discussion of specific preparedness actions residents should take during hurricane season. Evacuation considerations are discussed.

4. **TSUNAMI**
   An overview of the tsunami phenomenon followed by discussion of Hawaii's vulnerability as an Island State. Safety measures, do's and don'ts, and evacuation procedures are presented to include considerations for vertical evacuation.

5. **EARTHQUAKES, THEIR EFFECTS ON OAHU**
   A discussion of civil defense concerns in the wake of a damaging earthquake affecting downtown Honolulu and Waikiki. Highlights of civil defense response plans are presented.

6. **CIVIL DEFENSE SIRENS AND THE EMERGENCY BROADCAST SYSTEM**
   A discussion of the two siren signals, what they mean, and actions residents should take upon hearing them. A discussion of the Emergency Broadcast System and its use in providing official life-saving information and instructions to the general public.

7. **HAZARDOUS MATERIALS (HAZMAT)**
   A discussion of civil defense concerns associated with the production, transportation, storage, use, and disposal of hazardous chemicals on Oahu. Discussion includes the Emergency Planning and Community Right-to-Know Act of 1986.

8. **CIVIL DEFENSE COMMUNICATIONS SYSTEM**
   A description of communications equipment and procedures utilized in the civil defense network.

9. **GUIDED TOUR OF THE EMERGENCY OPERATING CENTER**
   A 30-40 minute guided tour of the Oahu Civil Defense Emergency Operating Center located in the basement of the Honolulu Municipal Building, 650 South King Street. While single individuals can be accommodated, groups between 15-20 people are preferred. Classes of school children are welcome. Appointments are requested.

WE ARE CONCERNED FOR YOUR SAFETY. YOU SHOULD BE TOO!

The Speakers Bureau is especially helpful to the following groups:

- Schools (students and staff)
- Businesses
- Security Agencies
- Hotels
- Transportation Groups
- Hospitals
- Military Organizations
- Civic Clubs
- Scouts
- Church Groups
- Federal, State and County Departments
- Radio and Television Stations
- Print Media

CIVIL DEFENSE
Warnings and Procedures

Make Individual/Family Plans in Advance.

During Any Civil Defense Emergency Listen to Your Local Radio Station for Information and Instructions

When Sirens Sound - Listen to Your Radio for Emergency Information and Instructions

HURRICANES

(high winds, heavy rain, flooding, damaging surf)
WATCH ISSUED: Expect within 36 hours - *Get Ready.*
WARNING ISSUED: Expect within 24 hours - *Take Action.*
SIRENS SOUND: Listen to radio/TV for instructions. Assemble survival kit. Fill car gas tank. Cover windows with boards or tape. Secure loose objects that may blow away. Leave areas that may flood. Stay indoors during high winds. When advised, evacuate to sturdy buildings, public shelters.

EARTHQUAKES

Occurs without warning.
INDOORS: Get under desk, table, supported doorway.
OUTDOORS: Stay in the open. Do not enter damaged buildings. Beware of fires, dam failures, downed power lines, aftershocks.
DRIVING: Stop. Stay in vehicle. Local strong earthquake may cause tsunami. Go to high ground.

TSUNAMIS

(series of destructive ocean waves affecting all shorelines)
May occur anytime with limited or no warning.
WATCH ISSUED: Tsunami possible - *Get Ready.*
WARNING ISSUED: Leave coastal areas. Refer to maps on following pages.
SIRENS SOUND: listen to radio/TV for information. If in safe area - *Stay There.* Wait for an *All Clear.* Local Strong earthquake may cause tsunami. Go to high ground.

HIGH SURF

All coastlines vulnerable.
ADVISORY ISSUED: Use caution in beach activities.
REMAIN ALERT: Leave areas that are threatened. Follow instructions of public safety officials.

FLASH FLOODS

(rapid flooding of streams, valleys, flood prone areas) Caused by heavy rains.
WATCH ISSUED: Flooding possible - *Be Alert.*
WARNING ISSUED: Flooding imminent or occuring. Go to high ground if in flood prone areas. Do not enter flooded roads, paths, streams

FALLOUT RADIATION

Caused by nuclear detonation or accident.
SIRENS SOUND: Listen to radio/TV for information - *Take Action.* Go to fallout shelter marked with symbol at left. Any building gives some protection

CIVIL DEFENSE
Warnings and Procedures

People in the State of Hawaii must be prepared for problems that could arise as a result of a natural disaster or warfare. The Civil Defense information on these pages is provided by the Civil Defense Systems in Hawaii and published as a public service by GTE Hawaiian Tel.

CIVIL DEFENSE PREPAREDNESS INFORMATION

Civil Defense booklets and other preparedness information are available at County Civil Defense Agencies. Visit the Maui Civil Defense Agnecy, Kalana O Maui Building, 200 South High St., Wailuku 96793 or telephone 243-7721 for recorded emergency information.

INDIVIDUAL PREPARATION

You must be capable of caring for yourself in an emergency if you are to assist your family and contribute to the community survival effort. There are certain things you can learn and do to help you prepare for and cope with almost any type of disaster.

Be prepared to expect the unexpected. Don't wait for instructions to take obviously necessary actions.

Keep Calm. Take time to think. Then take the necessary actions that the situation calls for. Usually these will be actions you have planned in advance, or that you take after hearing radio messages over the Emergency Broadcast System.

Know the warning signals and where shelters are located.

Keep a survival kit for home use or to take to a shelter.

HOME SURVIVAL KIT CHECKLIST

- ☐ portable radio
- ☐ Extra batteries
- ☐ 5-day non-perishable
- ☐ Candles
- ☐ Matches
- ☐ First Aid Kit
- ☐ Medications
- ☐ 5-day non-perishable food supply
- ☐ Ice chest
- ☐ Containers of water (minimum 2 qts. per person per day)
- ☐ Sleeping bags or blankets
- ☐ Personal toilet articles & sanitary needs
- ☐ Change of clothing for each household member
- ☐ Fuel for stoves, hibachis or lanterns
- ☐ Masking tape for windows & glass doors
- ☐ Extra pet food

IF YOU EVACUATE . . .

Evacuation Kit

- ☐ Portable radio
- ☐ Flashlight
- ☐ Extra batteries
- ☐ First Aid Kit
- ☐ Non-perishable food (for 5 days)
- ☐ Manual can opener
- ☐ Containers of water
- ☐ Sleeping bags/blankets/air mattress
- ☐ Special medications/diets
- ☐ Change of Clothing
- ☐ Personal toilet articles and sanitary needs.

Leaving Home

- ☐ Assemble family: Leave note for those absent. Give time, destination, phone number.
- ☐ Wedge sliding doors
- ☐ Secure residence: Lock windows and doors.
- ☐ Take evacuation kit.
- ☐ Provide for pets. NO PETS IN SHELTERS.
- ☐ Shut off electricity and gas.

Returning Home

- Exercise caution! Check for:
- Structural damage
- Electrical short circuits
- Gas Leaks
- Broken water lines
- Contaminated food/water

EVACUATION INSTRUCTIONS

Follow Civil Defense instructions, to include shelter information, issued through Police and Fire Department units, the Emergency Broadcast System, and Civil Air Patrol aircraft. You will not be asked to leave your home unless your life is seriously threatened.

EMERGENCY BROADCAST SYSTEM (EBS)

Civil Defense instructions are broadcast over radio, television, and Cable TV systems. Tune to your local station when you hear the warning sirens. For video broadcasts directly from the State Emergency Operating Center, tune to the Public TV station or the Cable TV program information channel. A monthly test of the EBS and warning sirens is conducted at 11:45 a.m. the first State working day of each month.

NATIONAL WEATHER SERVICE NOTIFICATIONS

The National Weather Service and the Pacific Tsunami Warning Center coordinate with Civil Defense to issue weather and tsunami advisories, bulletins, watches and warnings. They inform the public through local radio, television, and newspaper announcements.

CIVIL DEFENSE
Warnings and Procedures

When YOU hear the Civil Defense sirens, turn on your radio and LISTEN for instructions.

Do Not Use The Telephone!

Siren Signal	Signal	Action
Steady Siren Tone – 3 minutes – – Repeated as necessary –	**Attention Alert Signal**	**Tune Your Radio** to any station: LISTEN to emergency information and instructions broadcast by Civil Defense. TAKE NECESSARY ACTIONS.
Wailing Siren Tone – 3 minutes – – Repeated as necessary –	**Attack Warning Signal**	**Take Protective Action:** An attack against the U.S. has been detected. Take best protective shelter immediately: Lie close to walls, under desks or tables away from windows. Shield eyes. As practical, listen to the radio for Civil Defense emergency information and instructions.
No Siren Signal	**Attack Without Signal**	**Fall Flat!** Shield eyes from flash. After blast, get inside a fallout shelter
No Siren Signal	**All–Clear** (following an Alert or Attack Warning)	**Listen** for Civil Defense emergency information and instructions on your radio

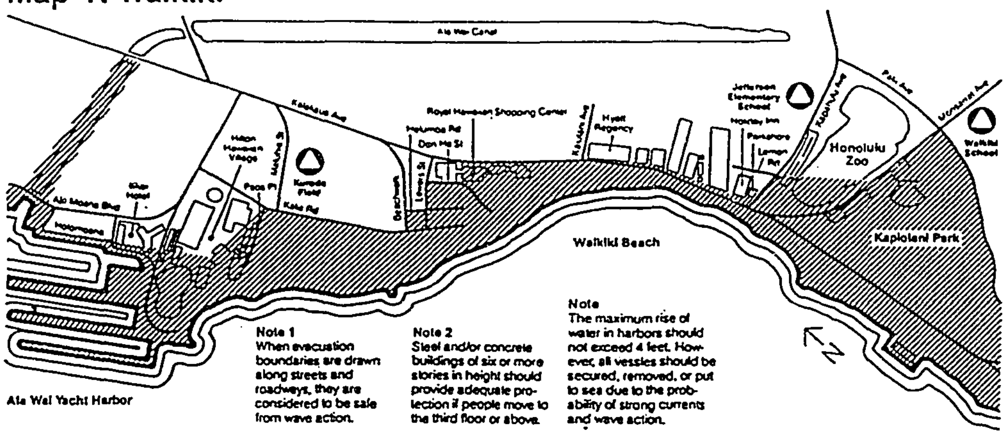
Evacuate all shaded areas.
See tsunami instructions on page . . .

Civil Defense

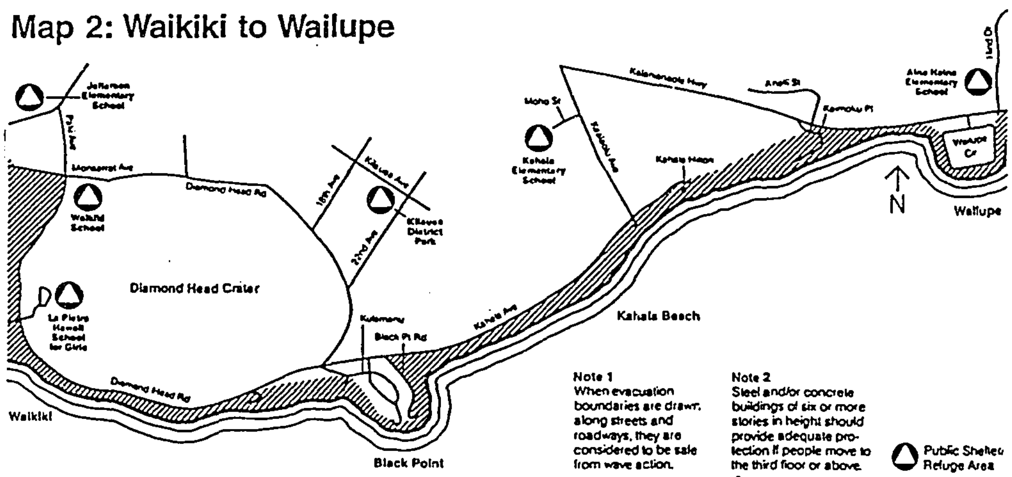
Tsunami Evacuation Maps

Produced by the Joint Institute for Marine and Atmospheric Research, University of Hawaii, in cooperation with the State of Hawaii Civil Defense System.

Map 1: Waikiki



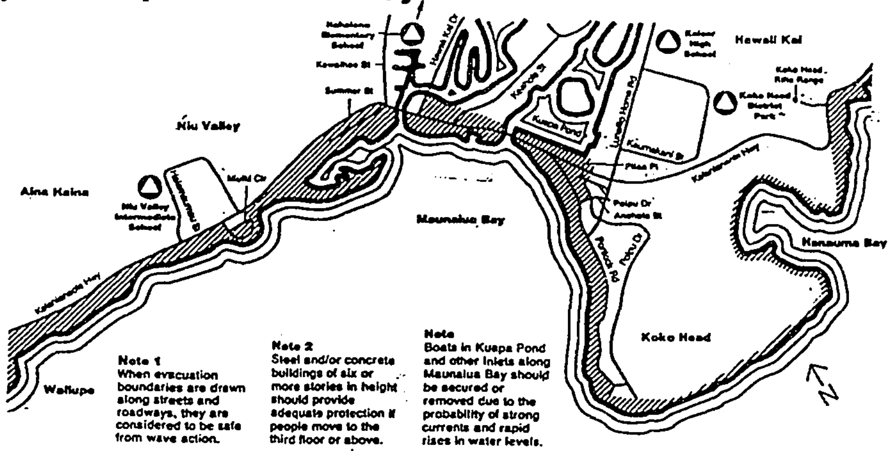
Map 2: Waikiki to Wailupe



Evacuate all shaded areas.
See tsunami instructions on page . . .

Civil Defense
Tsunami Evacuation Maps

Map 3: Wailupe to Hanauma Bay

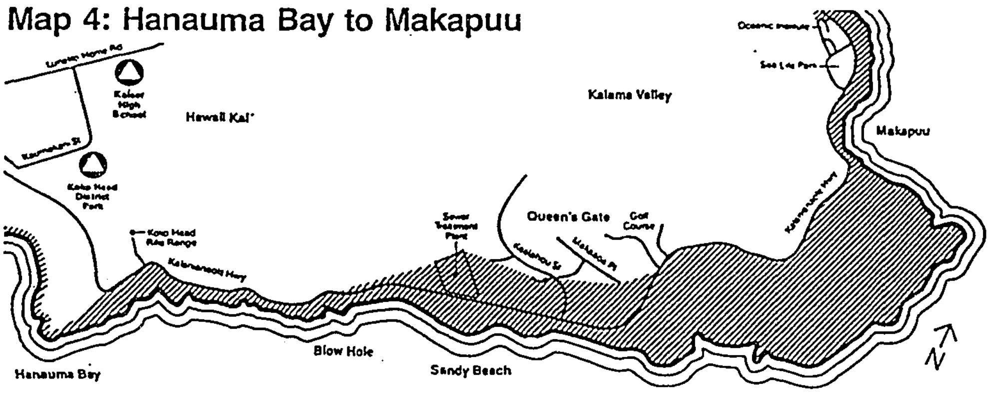


Note 1
When evacuation boundaries are drawn along streets and roadways, they are considered to be safe from wave action.

Note 2
Steel and/or concrete buildings of six or more stories in height should provide adequate protection if people move to the third floor or above.

Note
Boats in Kuapa Pond and other inlets along Maunalua Bay should be secured or removed due to the probability of strong currents and rapid rises in water levels.

Map 4: Hanauma Bay to Makapuu



Note 1
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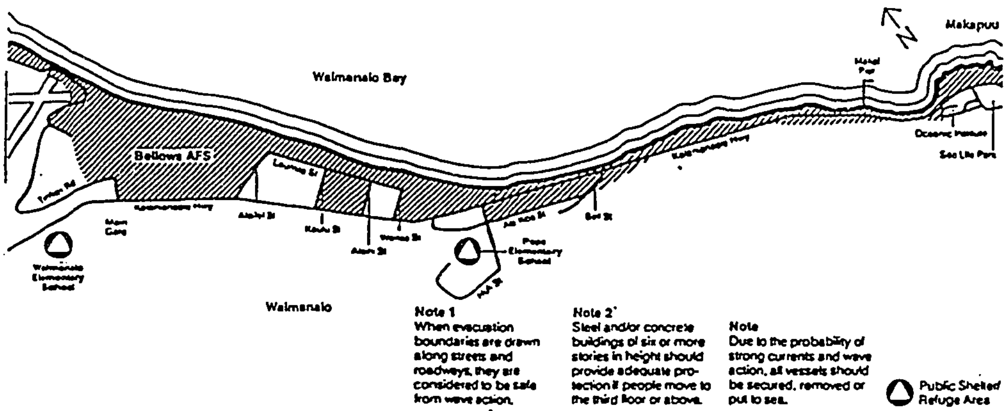
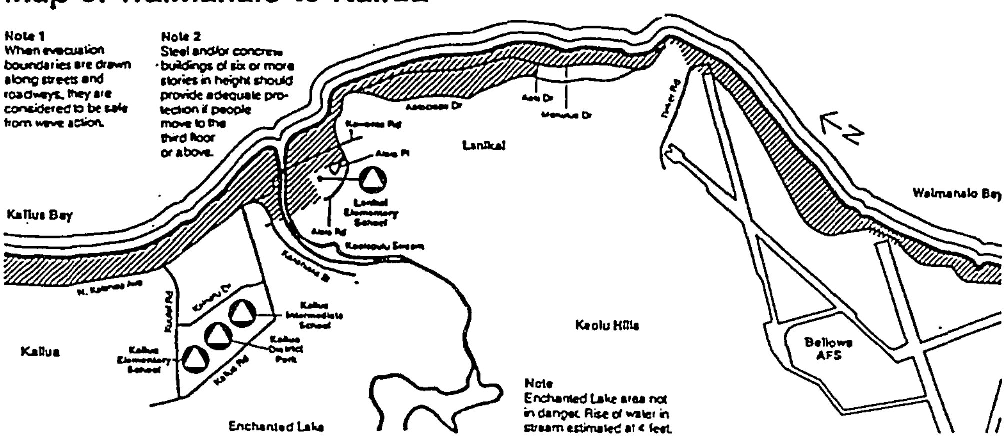
Public Shelter/ Refuge Area

Civil Defense
Tsunami Evacuation Maps

Map 5: Makapuu to Waimanalo



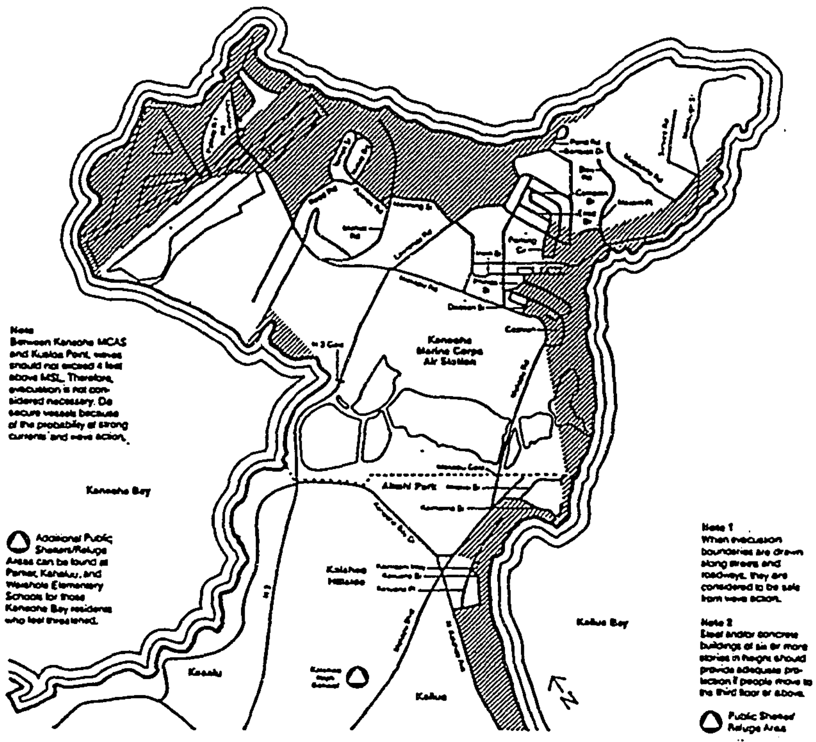
Map 6: Waimanalo to Kailua



Civil Defense
Tsunami Evacuation Maps

Evacuate all shaded areas.
See tsunami instructions on page ...

Map 7: Kailua to Kaneohe Bay

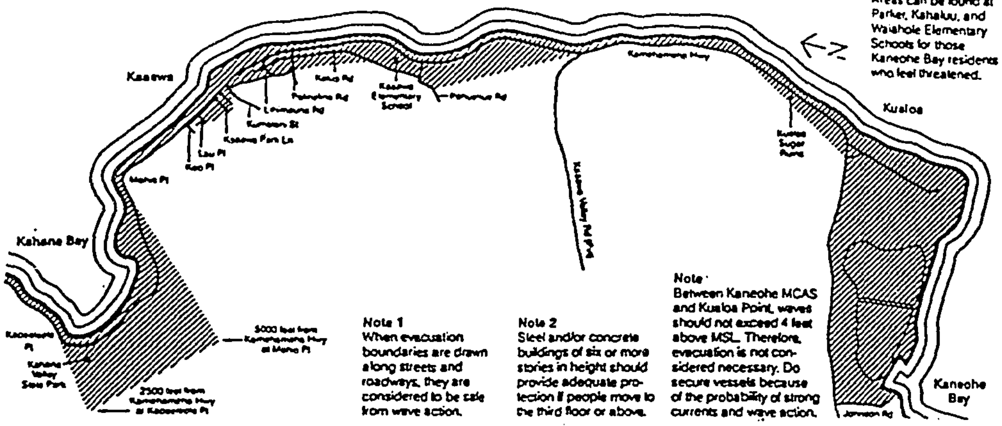


Evacuate all shaded areas.
See tsunami instructions on page . . .

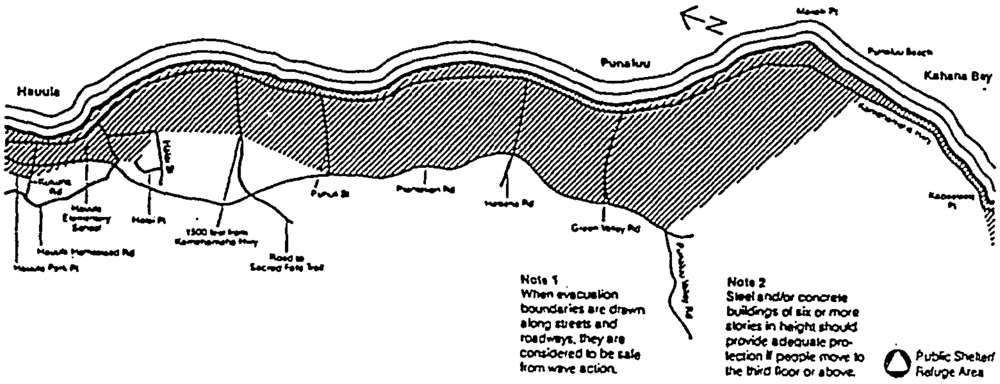
Civil Defense

Tsunami Evacuation Maps

Map 8: Kaneohe Bay to Kahana Bay



Map 9: Kahana Bay to Hauula



Evacuate all shaded areas.
See tsunami instructions on page . . .

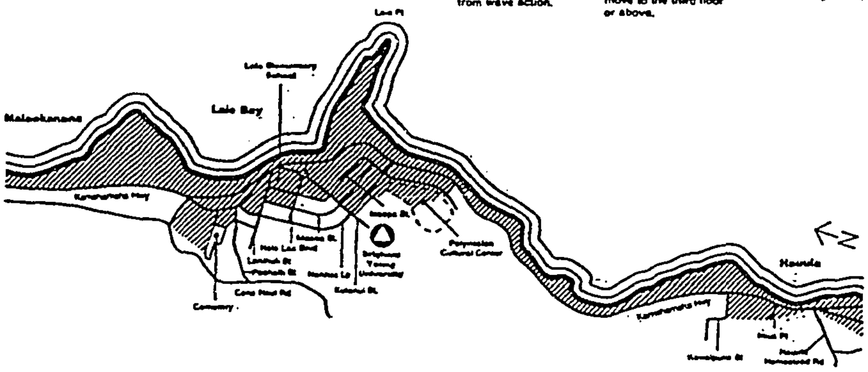
Civil Defense
Tsunami Evacuation Maps

Map 10: Hauula to Malaekahana

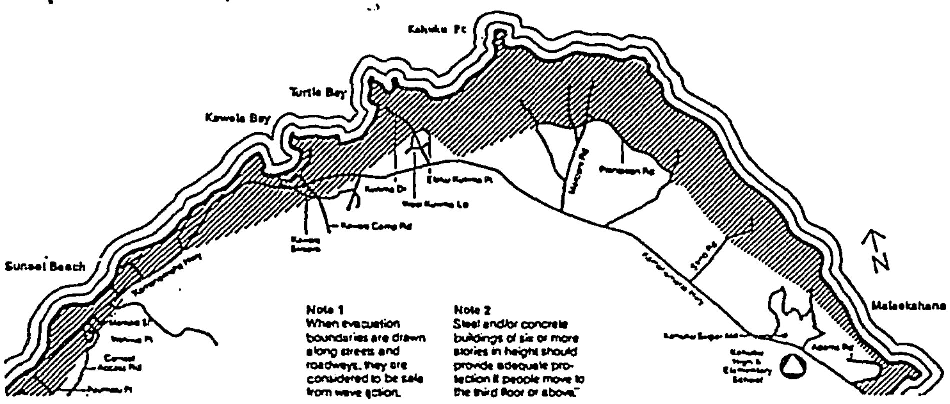
Note 1
When evacuation boundaries are drawn along streets and roadways, they are considered to be safe from wave action.

Note 2
Steel and/or concrete buildings of six or more stories in height should provide adequate protection if people move to the third floor or above.

Tsunami Public Shelter/ Refuge Area

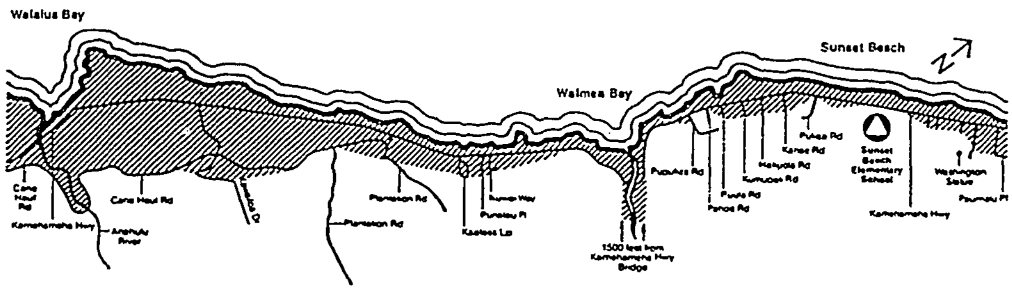


Map 11: Malaekahana to Sunset Beach



Civil Defense
Tsunami Evacuation Maps

Map 12: Sunset Beach to Waialua Bay



Note 1
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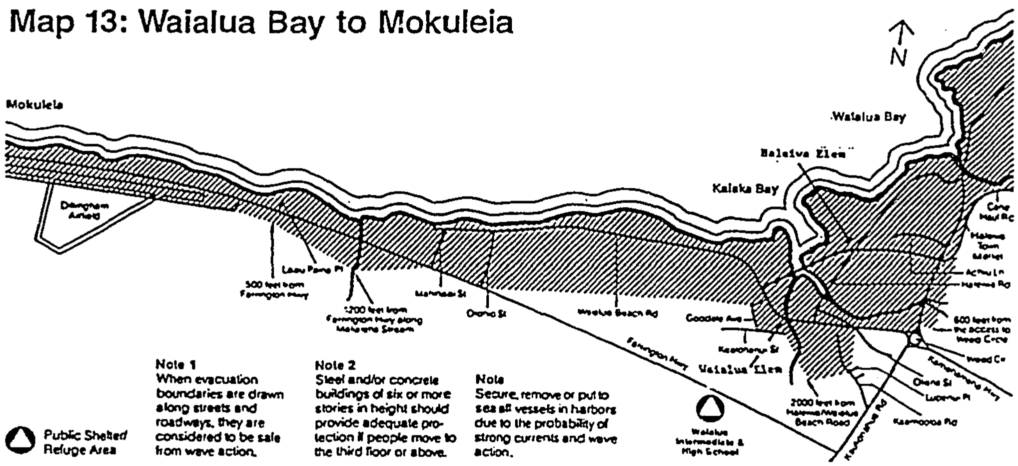
Note 2
Steel and/or concrete buildings of six or more stories in height should provide adequate protection if people move to the third floor or above.

Note
Secure, remove or put to sea all vessels in harbors due to the probability of strong currents and wave action.

Map 13: Waialua Bay to Mokuleia



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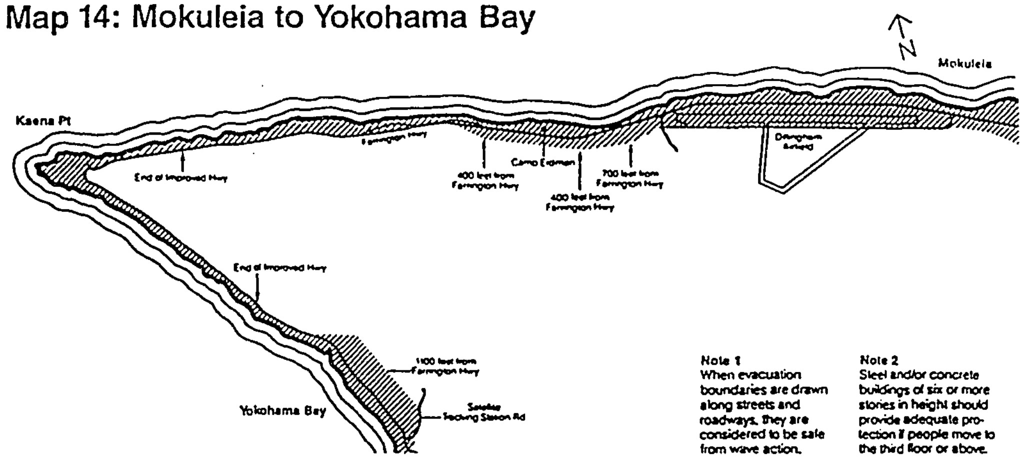
Public Shelter/Refuge Area

Civil Defense
Tsunami Evacuation Maps

Evacuate all shaded areas.
See tsunami instructions on page . . .

Map 14: Mokuleia to Yokohama Bay



Note 1
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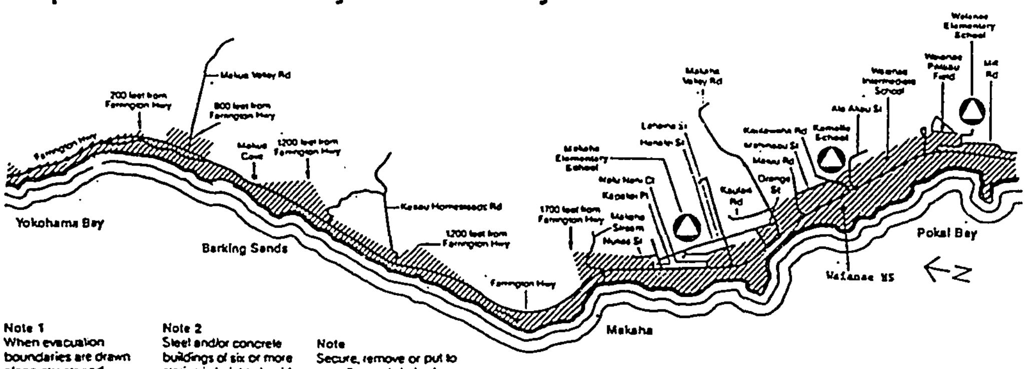
Map 15: Yokohama Bay to Pokai Bay



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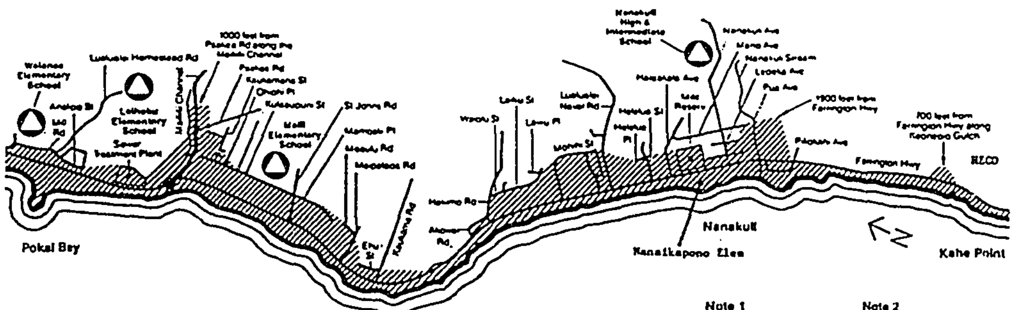
Public Shelter/ Refuge Area

Civil Defense
Tsunami Evacuation Maps

Map 16: Pokai Bay to Kahe Point



Note
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Note 1
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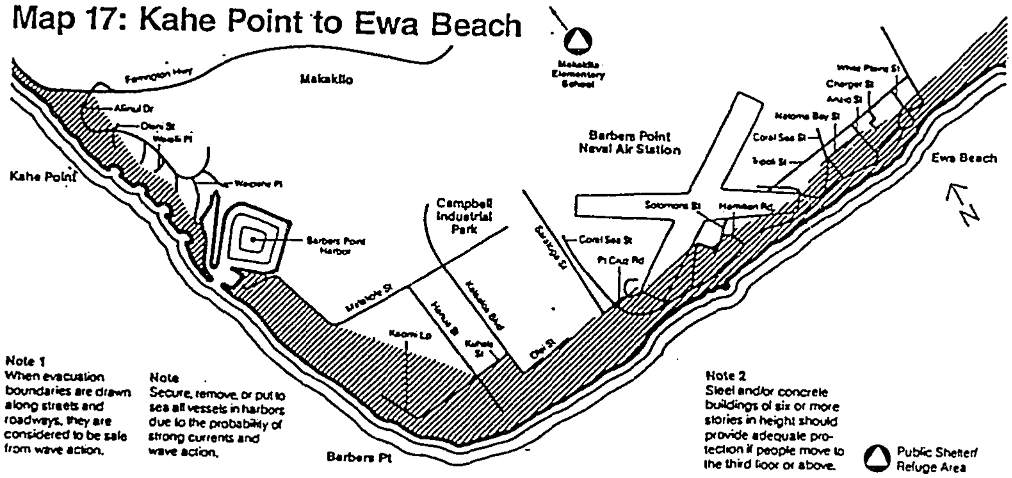
Map 17: Kahe Point to Ewa Beach



Note 1
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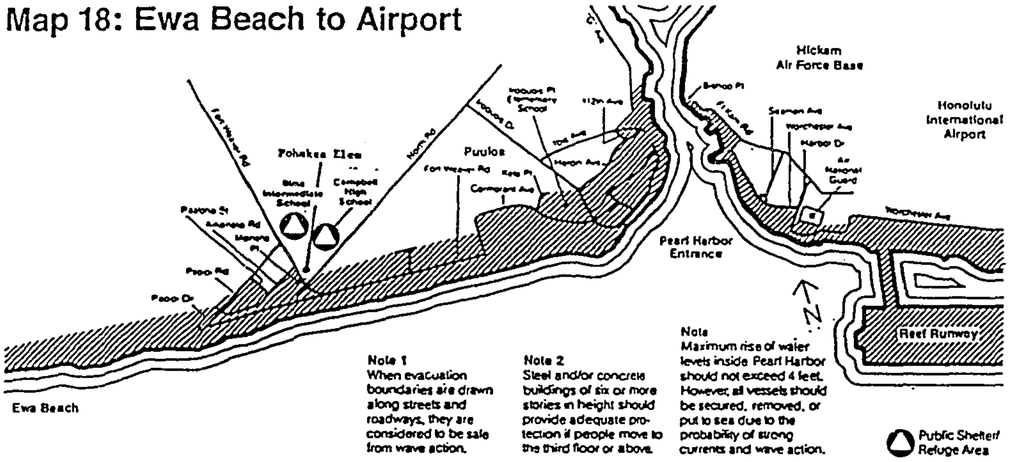
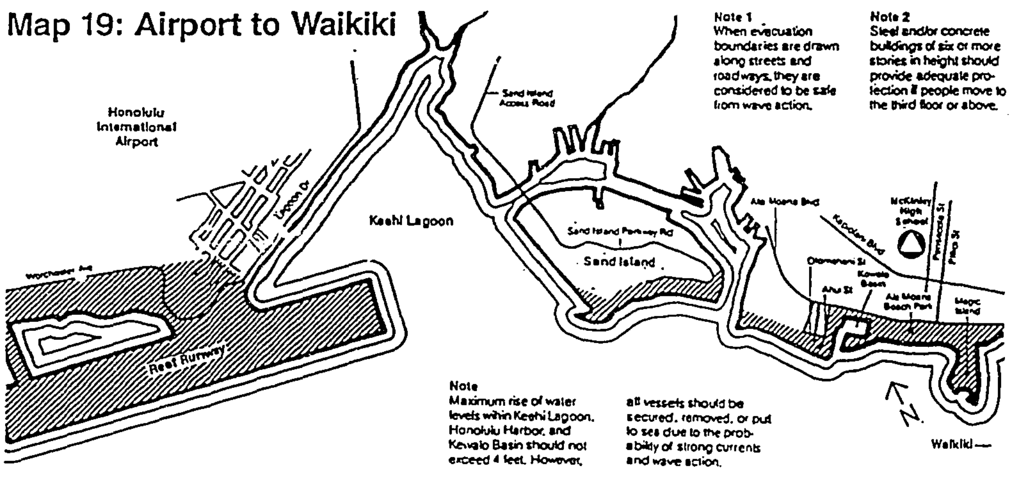
Public Shelter/ Refuge Area

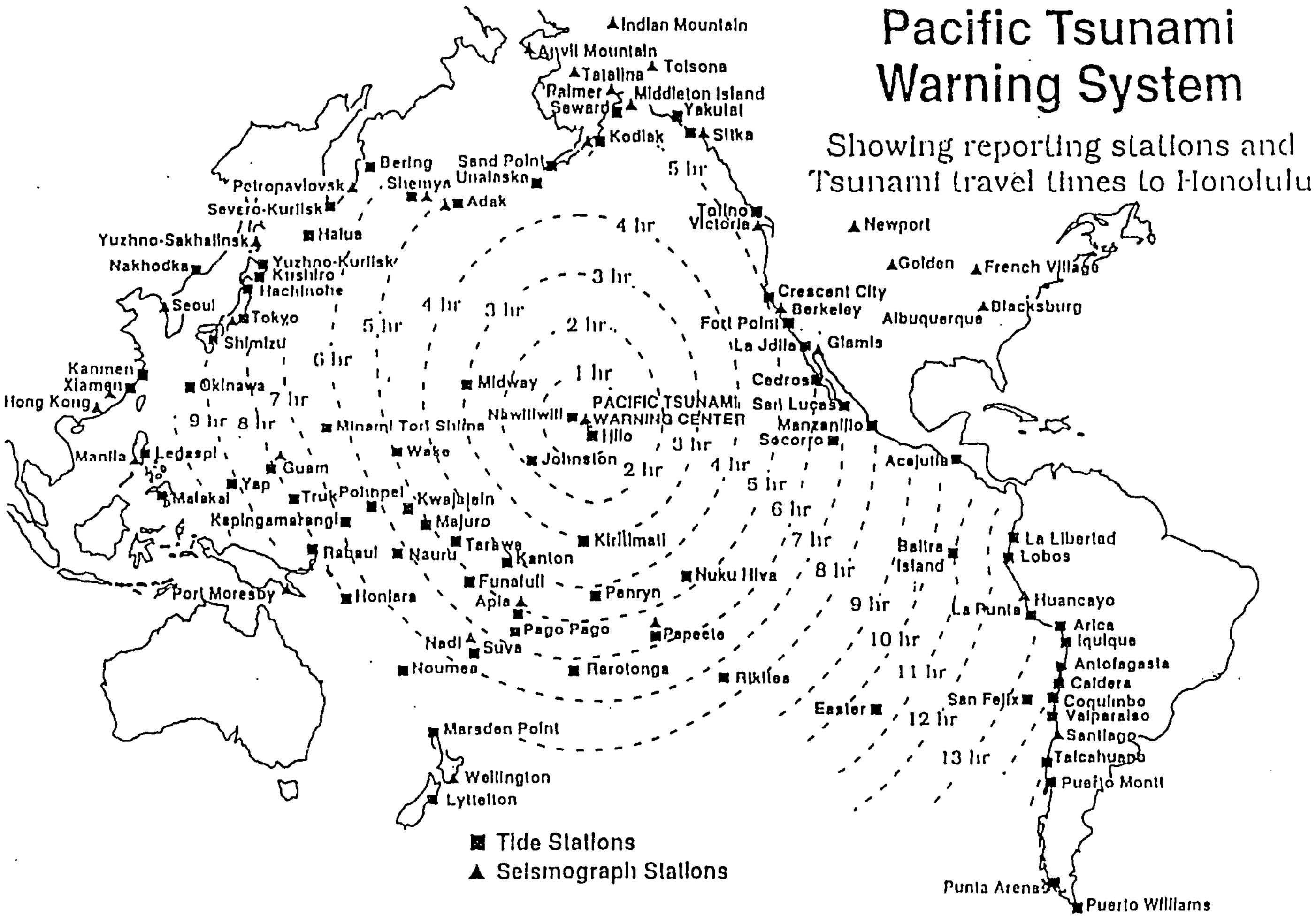
Civil Defense
Tsunami Evacuation Maps

Map 18: Ewa Beach to Airport



Map 19: Airport to Waikiki




Pacific Tsunami
Warning System
Showing reporting stations and
Tsunami travel times to Honolulu
Indian Mountain
Anvil Mountain
Tatalina
Tolsona
Palmer
Middleton Island
Seward
Yakutat
Kodiak
Sitka
Sand Point
Unalaska
Bering
Shemya
Adak
Petropavlovsk
Severo-Kurilsk
Yuzhno-Sakhalinsk
Nakhodka
Hakodate
Yuzhno-Kurilsk
Kushiro
Hachinohe
Seoul
Tokyo
Shimizu
Kanmen
Xiamen
Hong Kong
Okinawa
Manila
Legaspi
Malakal
Yap
Guam
Truk
Pohnpei
Kwajalein
Kapingamarangi
Majuro
Tarawa
Rabaul
Nauru
Kanton
Port Moresby
Honiara
Funafuti
Apia
Pago Pago
Nadi
Suva
Noumea
Marsden Point
Wellington
Lyttelton
Minami Tori Shima
Wake
Midway
Nawiliwili
PACIFIC TSUNAMI WARNING CENTER
Hilo
Johnston
Kiritimati
Penryn
Nuku Hiva
Papeete
Rarotonga
Rikitea
Easter
Tofino
Victoria
Newport
Golden
French Village
Crescent City
Berkeley
Fort Point
Albuquerque
Blacksburg
La Jolla
Glamis
Cedros
San Lucas
Manzanillo
Socorro
Acajutla
Baltra Island
La Libertad
Lobos
La Punta
Huancayo
Arica
Iquique
Antofagasta
Caldera
San Felix
Coquimbo
Valparaiso
Santiago
Talcahuano
Puerto Montt
Punta Arenas
Puerto Williams
1 hr
2 hr
3 hr
4 hr
5 hr
6 hr
7 hr
8 hr
9 hr
10 hr
11 hr
12 hr
13 hr
Tide Stations
Seismograph Stations

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